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Critical Limitations of the 1980 U.S. Bureau of Mines Siskind et al. Study (RI 8507)

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ABSTRACT

The 1980 study by David E. Siskind et al., *"Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting"* (RI 8507), has become a foundational reference for regulatory vibration thresholds across North America and other jurisdictions. Despite its widespread citation, the study suffers from critical limitations in scope, methodology, and applicability — particularly when used as a universal standard in environmental assessments and quarry blast-impact studies, and has the potential to mislead the public and decision makers. This article examines the structural, diagnostic, and planning-related shortcomings of RI 8507, with a focus on its misalignment with Ontario's diverse receptor types, zoning frameworks, and environmental sensitivities. The analysis reveals that RI 8507 lacks temporal granularity, lacks receptor diversity, lacks diagnostic rigour, and fails to account for modern infrastructure, perceptual impacts, and cumulative exposure over time. These deficiencies undermine its credibility as a universal benchmark and necessitate receptor-specific calibration aligned with contemporary planning and environmental standards.

Keywords: Vibration impact assessment; Receptor-specific calibration; Quarry licensing; Environmental compatibility; Planning policy analysis; Structural fatigue modelling

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1. INTRODUCTION

RI 8507, published by the U.S. Bureau of Mines in 1980, sought to determine safe levels of ground vibration from surface mine blasting that would not cause damage to residential-type structures (Siskind et al., 1980).[1] Based on 219 production blasts across 76 homes — most of wood-frame construction — the study established a 5.0% probability threshold for "cosmetic" damage at a peak particle velocity (PPV) of 0.5 inches per second (12.7 mm/s). Over time, this threshold has been adopted as a *de facto* standard in proponent-driven environmental or blast impact assessments, including in Ontario, where it has been used to justify large-scale blasting quarry proposals.

The U.S. Office of Surface Mining Reclamation and Enforcement (OSMRE) defines Peak Particle Velocity (PPV) as:

> "The maximum instantaneous velocity of a particle at a point during a given interval." (OSMRE, ARblast Technical Resource, 2017)

In practical terms, Peak Particle Velocity (PPV) measures how fast the ground moves at its most intense moment during a blast or vibration event. It describes the maximum speed at which a small portion of the ground shakes when a seismic wave passes through a specific location, typically where a structure or receptor is situated. A seismograph installed at the point of reception records this value, which is then used to assess the potential for cosmetic or structural damage. As acknowledged at p. 5 of the study, seismic energy from blasting maintains particle velocity amplitudes as it travels between materials (rock to soil), due to conservation of energy. However, the frequency and duration of vibration change significantly depending on the ground medium. Softer soils and longer distances stretch the vibration into low-frequency wave trains, which shake the ground more gently but over longer periods and across broader areas. These low-frequency vibrations—especially those below 10 Hz—are more likely to couple with the natural resonant frequencies of residential structures, typically in the 4 to 12 Hz range.

These low-frequency wave trains propagate radially outward from the blast site, concentrating energy along the ground surface. Unlike linear wave paths, radial propagation means that receptors located in any direction from the source—regardless of alignment—may experience significant vibration exposure. This radial spread, combined with surface coupling, increases the likelihood of resonance effects in nearby structures. When vibration frequency aligns with a building's natural frequency, it can induce whole-structure distortion known as racking—a shearing motion that deforms the building frame, like a rectangle twisting into a parallelogram. Racking introduces shear stresses across walls, joints, and foundations, increasing the risk of cracking, warping, and structural failure. These findings underscore the importance of evaluating not just PPV magnitude, but also frequency content, wave duration, and site-specific soil conditions when assessing vibration impacts on receptors. Long-term repeated blasting, an issue not addressed in the study, can lead to cumulative structural fatigue, increased receptor sensitivity, and elevated risk of cosmetic and structural damage—even if individual blasts remain below regulatory thresholds. Over time, repeated exposure can amplify vibration effects due to soil densification, accumulated material fatigue, and resonance buildup.

Biessikirski & Jakóbczyk (2025) applied an integrated monitoring system that combined geophones to record ground motion and strain gauges to measure stress inside a two-storey brick residential building with a concrete ceiling and no basement, connected to a second building, a car repair shop. The structure was located between 320 and 720 metres from the blasting zone, recording 45 blast events, each lasting about two seconds. Their monitoring showed how blast vibrations actually affect building materials. They found that most vibrations were low frequency (5–13 Hz), overlapping with the natural resonance range of many buildings, which amplified stresses and prolonged shaking inside the

[1] The test structure in *Report of Investigations 8896: Effects of Repeated Blasting on a Wood-Frame House* (Stagg, Siskind, Stevens, & Dowding, 1984) was a wood-frame raised bungalow approximately one year old and 1,144 ft² (approx. 106.2 m²), constructed on a concrete slab with an unfinished concrete block basement, electrical service, and heating and cooling systems, but no plumbing, no interior finish work (e.g., doors, cabinetry), and no home furnishings. It was not fit for occupancy, having been purpose-built for vibration monitoring and left unoccupied throughout the study. Over a two-year period, it was subjected to 587 coal mine production blasts, with peak particle velocities ranging from 0.10 to 6.94 in/s (approx. 2.5 to 176.4 mm/s). Mechanical shaking was later applied to simulate fatigue, but this method fails to replicate the impulsive, multi-frequency seismic waveforms generated by quarry blasting—namely P-waves, S-waves, and surface waves—which interact with subsurface geology and structural components in ways that continuous harmonic shaking cannot. The absence of plumbing, furnishings, and occupancy-related systems eliminates key vibration transmission pathways and resonance amplifiers found in real-world receptors. As such, RI 8896 is diagnostically inappropriate for modern, high-capacity quarry operations and cannot be used to justify licensing without receptor diversity modelling or provisions for licence expiry and periodic review. Retrieved from: https://stacks.cdc.gov/view/cdc/201767

building compared to the ground. Importantly, the peak particle velocity (PPV) values they recorded were relatively low, around 1.0–2.5 mm/s, well below the cosmetic threshold of 12.7 mm/s set by Siskind in 1980, yet resonance effects still produced significant structural stress. This demonstrates that Siskind's PPV-only approach is outdated, since modern receptor analysis must account for frequency content, resonance, and direct stress measurements rather than relying solely on distance-based PPV criteria.

Taken together, these physical and structural dynamics reveal that RI 8507's narrow scope, outdated assumptions, lack of diagnostic rigour, lack of scientific credibility, and lack of receptor diversity render it unsuitable for universal application. Ontario's planning frameworks — including the Niagara Escarpment Plan, municipal zoning by-laws and Official Plans, and heritage overlays — require a more nuanced understanding of receptor-specific vibration impacts across a wide range of receptor types. Without such calibration, reliance on RI 8507 risks misleading councils, tribunals, and the public when evaluating quarry proposals for permanent land use compatibility and in preventing adverse blasting impacts.

2. STATED PURPOSE OF THE STUDY

The stated purpose of the 1980 study by David E. Siskind and colleagues, titled *"Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting"* and published by the U.S. Bureau of Mines, was to: "Determine safe levels of ground vibration from blasting that would not cause damage to residential-type structures." The study involved:

- Direct measurements of ground vibration and structural response in 76 homes of undocumented age across nine surface mine locations subjected to 209 documented production blasts. However, the study did not disclose the number of blast holes (detonations) per blast, delay timing, a chronological blast schedule, or a site-specific event log. Table 1 indicates 20 quarry blasts, 170 coal blasts, 19 iron blasts, and 32 construction blasts, for a total of 241 blasts — though only 209 were used for structural response analysis.

Table 1: Blast Type Breakdown and Structural Relevance in RI 8507

Blast type	*Total Blasts*	*Used for structure Response*	*Receptor type*
Coal	170	Yes	Residential structures
Quarry	20	Yes	Residential structures
Iron	19	Yes	Residential structures
Construction	32	No	Not linked to the structure data
Total	241	209	76 residential structures

- Over 70 of the structures subjected to blasting consisted of wood-frame construction, and 56 of 76 structures had basements, of which 24 were finished, with the study cautioning as follows:
  Safe vibration levels for blasting are given in table 13, being defined as levels unlikely to produce interior cracking or other damage in residences. Implicit in these values are assumptions that the structures are sited on a firm foundation, do not exceed 2 stories, and have the dimensions of typical residences, and that the vibration wave trains are not longer than a few seconds (Siskind et al., 1980, p. 58)
- *Wave train scale mismatch:* The blast-induced ground vibration waves that reach homes are far larger than the footprint of a typical residence. A vibration wave train lasts about 3–4 seconds, and with ground wave speeds of roughly 800 feet per second (244 metres per second), the train extends nearly 3,000 feet (915 metres) in length. At distances greater than 1,000 feet (305 metres), these vibrations often have dominant frequencies of 8–10 Hz. At 10 Hz, each cycle of ground motion spans about 80 feet (24 metres), meaning the front of a house is lifted while the back is simultaneously pulled downward, and vice versa. This alternating distortion repeats 30–40 times during a single blast event. When the frequency of these repeated motions coincides with the natural frequency of the house, resonance occurs. The structural response is amplified, producing

displacements several times greater than those at the foundation, and significantly increasing the risk of cracking, racking, and other forms of damage.[2]

- *Multiple explosions per blast:* In practice, a single blast event consists of multiple individual explosions fired in sequence. Each charge contributes its own vibration pulse, and the overlapping pulses lengthen the wave train beyond the few seconds assumed in Siskind's criteria. This extended shaking increases the number of distortion cycles experienced by a house, broadens the frequency content, and raises the risk of resonance when repeated pulses coincide with the natural frequency of the structure. The cumulative effect of multiple explosions, therefore, amplifies displacement and damage potential well beyond what is predicted by PPV limits.
  If structures in semi-rural or rural communities are built under different building codes—or with no codes at all in diverse soil conditions (Bapir et al., 2023) — the assumptions in Siskind's 1980 criteria become even less reliable.
- *Code variability:* Homes in the Siskind study were built under relatively uniform U.S. residential codes of the time. Rural structures may follow older, less stringent codes or local practices that don't enforce vibration-resistant design (Singh et al., 2008; Pan et al., 2025).
- *No codes at all:* In many rural areas, especially for farmhouses, barns, or heritage buildings, construction may have been informal, without engineering oversight. These buildings often lack reinforcement, standardized foundations, or modern materials, making them more vulnerable to cracking and resonance.
- *Ontario Building Code:* The Ontario Building Code was enacted in 1975[3], but many rural Ontario structures — particularly older farmhouses, barns, and heritage buildings — were built before its adoption or under exemptions. Although the actual number is unknown, housing data confirm that a substantial share of rural dwellings predate or fall outside modern building codes, but they contain no provisions for blast vibration resilience. This means that both non-code rural structures and code-compliant typical homes remain vulnerable when exposed to prolonged blasting operations. In rural communities, 31% of dwellings were constructed in 1960 or earlier, and another 28% were constructed from 1961 to 1980. 29% of dwellings in indigenous communities need major repairs, which is much higher than the provincial average of 6% (Rural Ontario Institute, 2023).
- *Structural diversity:* Without consistent codes, there is wide variation in wall thickness, mortar quality, framing methods, and foundation types. This variability means vibration thresholds cannot be generalized—some buildings may fail at much lower PPV levels than the "safe" limits suggested (Singh et al., 2008).
- *Variable footprints:* The study assumed "typical residences" with uniform dimensions, but rural buildings often have irregular or expansive footprints—long farmhouses, wide barns, or heritage stone structures. These geometries alter modal frequencies and foundation interaction, lowering natural frequencies and increasing susceptibility to low-frequency blast vibrations. The assumption of uniform footprints, therefore, underestimates resonance risks.
- *Court acknowledgement and resonance amplification:* According to the Surface Mining Control and Reclamation Act (SMCRA) and F-SMCRA, low-frequency blasting is problematic and can cause structural damage, as found in *Jarrett v. DNR and Amax Coal Company* (1992).[4]

  > *113. As with all other structures, homes have one or more natural (or harmonic or resonant) frequencies. The mathematical effect of a natural frequency is that induced vibrations, which are the same frequency as a natural frequency, will cause vibrations to increase with time rather than decrease with time. As a practical matter, this means the midwall response of a home subjected to vibrations from a blast (or any other source) could be a displacement of up to four times the displacement at the foundation. It can also cause "racking" or shaking of the structure.*
  >
  > *114. When such a phenomenon occurs, it clearly places considerable stress on the mortar between bricks, plaster walls, and corners of a structure.*

[2] Information provided by Dr. Kiger (personal communication)

[3] The Ontario Building Code was first enacted under *Ontario Regulation 925/75* in 1975 and is now governed by the *Building Code Act, 1992*. See Ontario Ministry of Municipal Affairs and Housing (1975). *Ontario Building Code, O. Reg. 925/75.* Government of Ontario. Updated under the *Building Code Act, 1992*, S.O. 1992, c. 23.

[4] *Jarrett v. DNR and Amax Coal Company,* 5 CADDNAR 265 (1992), https://www.in.gov/nrc/decision/89-106r.v5.html.

> *115. …OSM report RI 8507 indicates the natural frequency of wood frame structures is in the 5-10 Hz range for racking. Natural frequencies of one-story homes can be as high as 18 Hz, but of course, the initial displacement at 18 Hz is only 1/2 of the displacement of a 9 Hz frequency for the same peak particle velocity [PPV]. This study concludes that frequencies below 10 Hz are the most serious ones.*

- *Cottage conversions:* Market evidence shows that a growing share of Ontario cottages are being converted to year-round residences. According to RE/MAX Canada (2025), 30% of prospective cottage buyers intend permanent occupancy. Many cottages were originally built as seasonal dwellings, often lacking insulation, standardized foundations, or vibration-resistant design. Their conversion to permanent residences does not eliminate these vulnerabilities, further underscoring the inadequacy of typical dwelling-based PPV criteria for rural communities.
- *Regulatory gap:* Applying frequency-dependent criteria derived from code-compliant typical homes to non-code, structurally diverse rural buildings risks underestimating damage potential. It assumes a level of resilience that simply isn't present in many older, irregular, or informally built structures, leaving rural communities inadequately protected against longer vibration trains, cumulative blasting, and interior amplification effects, all of which increase damage risk in vulnerable rural structures.

  Siskind's subsequent 1990 study of Indiana coal mines confirmed that low-frequency blast vibrations are not rare anomalies but predictable outcomes of blasting practices and geology. These vibrations, often below 20 Hz, lasted longer than the "few seconds" assumed in RI 8507 and were amplified by overlapping detonations and soil conditions. With natural frequencies of rural homes in the 5–10 Hz range, the study concluded that frequencies below 10 Hz are the most serious. This reinforces that the derived PPV criteria fail to account for resonance amplification and extended wave trains, leaving rural Ontario communities exposed to underestimated risks (Siskind, 1990).
- Establishment of a 5.0% probability "cosmetic" damage threshold value per event based on peak particle velocity (PPV) of 0.5 inches per second (12.7 mm/s), which measures the maximum instantaneous speed of ground particle movement at a specific location, while the wavefront continues to propagate through the ground and structures before, at, and beyond the receptor.
- The amplification of ground vibrations was between 2 and 4 for interior structural elements compared to foundation measurements, especially walls and ceilings, and most pronounced at lower frequencies, especially below 20 Hz, with no direct measurement of blasts with dominant frequencies below 5 Hz (Dowding, 1996). The study focused narrowly on residential-type structures, excluding other receptor types and diagnostic criteria.
- The pre- and post-blast inspections of each structure were based solely on visual inspections, limited to accessible areas and excluding concealed finishes or structural elements behind drywall, ceiling panels, or within finished basements.
- Figure 10 of the U.S. Bureau of Mines study *RI 8507* presents a scatter plot of peak particle velocity (PPV) data collected from nine surface mine blasting operations. The data illustrate significant variability in ground vibration intensity at fixed scaled distances, undermining the reliability of universal PPV thresholds.[5]

Comparative Analysis of Two Scaled Distance Examples

A fixed scaled distance refers to a theoretical, predetermined threshold (e.g., 50 ft/lb$^{0.5}$) used to limit vibration levels when no seismic instrumentation is available. At 200 metres (scaled distance = 51.2 ft/lb$^{0.5}$):

- PPV values range from 0.033 in/sec (0.84 mm/s) to 1.3 in/sec (33 mm/s)
- This reflects a 40× variation and a 3,848% increase from minimum to maximum
- RI 8507 found that interior structural elements (e.g., walls, ceilings) can experience 2× to 3× amplification of ground-measured PPV, especially at frequencies below 20 Hz
- Applying this amplification to the upper PPV range yields 2.6 to 3.9 in/sec (66 to 99 mm/s) — well above the cosmetic damage threshold of 0.5 in/sec (12.7 mm/s)
- At 300 metres (scaled distance = 76.5 ft/lb$^{0.5}$):

[5] Miller Paving Limited's (Miller) quarry located in the Municipality of McNab/Braeside, Ontario: Dr. Kiger's Expert Report prepared January 12, 2015.

- PPV values range from 0.01 in/sec (0.25 mm/s) to 0.3 in/sec (7.6 mm/s)
- This reflects a 30× variation and a 2,900% increase
- Amplified PPV at the upper range reaches 0.6 to 0.9 in/sec (15.2 to 22.9 mm/s) — again exceeding the cosmetic damage threshold

These examples demonstrate that even at fixed scaled distances, PPV values fluctuate dramatically due to site-specific geology, blast configuration, and receptor conditions and configurations. RI 8507's reliance on scaled distance as a predictive tool is therefore diagnostically unstable.

- The study concedes that there may be no absolute minimum vibration damage threshold, and does not account for long-term repeated blasting:
  7. All homes eventually crack because of a variety of environmental stresses, including humidity and temperature changes, settlement from consolidation and variations in ground moisture, wind, and even water absorption from tree roots. Consequently, there may be no absolute minimum vibration damage threshold when the vibration (from any cause, for instance, slamming a door) could, in some cases, precipitate a crack about to occur. (p. 68)
- The study also cautions that
  Neighbors around mining operations and other blasting…require protection of their property and health so that they do not bear an unreasonable personal cost. (p. 4)

Protection of property extends beyond physical integrity to include economic impacts such as diminished market rental income and reduced market value, since blasting-related nuisance, stigma, and perception of risk can measurably erode both occupancy demand and resale potential even when PPV thresholds are technically met.

- The study does not disclose the number of production blasts each structure was exposed to, with table 3, listing 209 production blasts (20 involving quarries) across nine surface mines without a cumulative summary, showing Structure 58, near a coal mine, as having received seven blasts (Shots 203-209), while most structures were exposed to only one or two blasts, undermining the study's relevance for long-term, high-frequency quarry blasting operations in Ontario, where licences have no expiry date.
- The study does not disclose whether blasting took place above or below the water table, how deep the blasts were, or what the local groundwater conditions were like. Because its vibration limits were based on mines in dry ground, those numbers can't simply be applied to quarries that blast below the water table. When rock is saturated with water, vibrations travel differently — they can be stronger and carry farther, which increases the risk of damage to buildings and the environment. Without taking groundwater and geology into account, using the study's thresholds for deep or wet blasting gives a misleading picture of the vulnerability of nearby homes and ecosystems.
- The study thresholds are often cited as universal standards despite their narrow scope, leading to inappropriate application in environmental assessments and quarry blasting impact studies without receptor-specific calibration.
- The RI 8507 study was published in 1980, before modern environmental assessment standards and cumulative risk frameworks were enacted to protect the health, safety, and welfare of the community.

3. FOUNDATION FOR REGULATORY VIBRATION LIMITS

The stated research has become the foundation for regulatory vibration limits and has been widely cited in environmental assessments and quarry impact studies — including in Ontario by Golder Associates Inc. in its 2023 proponent-driven Blast Impact Assessment (Golder Associates Ltd., 2023) prepared for Votorantim Cimentos' (St. Mary's/CBM) proposed 800-acre blasting quarry in the Town of Caledon — despite its limited scope regarding receptor types (structures, monuments, site improvements, human and non-human life forms) and diagnostic criteria. Over a period of 100 years, at 100 blasts yearly, with 190 blast holes per blast, various stationary and mobile receptor types would be exposed to a total of 1.9 million detonations. This scale of detonations represents a level of structural, ecological, and human exposure that exponentially exceeds the short-term, low-frequency conditions modelled in RI 8507, rendering its thresholds diagnostically and regulatorily insufficient for modern large-scale quarry operations. RI 8507's most exposed structure received only seven blasts near a coal mine. It did not model

long-term fatigue, receptor diversity, or ecological thresholds — rendering its use in quarry licensing without periodic review or expiry date diagnostically inappropriate and regulatorily insufficient.

4. SENSITIVE RECEPTORS AND SENSITIVE LAND USES

In Ontario, the ARA, which controls the operational aspects of aggregate extraction, uses the term "sensitive receptor" as the point of vibration impact, which it defines as:

(a) a school or child care centre, or (b) any residence or facility at which at least one person sleeps, including a long-term care home, hospital, trailer park, or campground. (O. Reg. 244/97)

The ARA also imposes time-of-day restrictions on blasting. Specifically:

(5) A licence, aggregate permit, or wayside permit that authorizes blasting at the site is subject to the following conditions:

1. No blasting shall occur on a holiday, or between 6 p.m. and 8 a.m., unless the permittee holds an aggregate permit and there is no sensitive receptor located within 2,000 metres of the area in which the blasting takes place.

There is no rational basis for limiting this restriction on blasting to time-of-day alone on holidays, given that a licence has no expiry date. Post-COVID-19, as of Q2 2025, home-based businesses have become increasingly popular, according to Made in CA (2025). Locally, in 2019, pre-COVID-19, the Town of Caledon had 6,000 home-based businesses, double the 3,042 businesses with employees (MDB Insight Inc., 2020) and are supported by the policies of Section 2.6 Rural Lands in Municipalities of PPS (2024) and its Vision statement:

> Growth and development will be prioritized within urban and rural settlements that will, in turn, support and protect the long-term viability of *rural areas*, local food production, and the *agri-food network*. In addition, resources, including natural areas, water, aggregates, and agricultural lands, will be protected. Potential risks to public health or safety or of property damage from natural hazards and human-made hazards, including the risks associated with the impacts of climate change, will be mitigated….Above all, Ontario will continue to be a great place to live, work, and visit, where all Ontarians enjoy a high standard of living and an exceptional quality of life (p. 1).

A 2010 study (Wahid) of 49 Environmental Impact Assessment (EIA) reports from 1995 to 2002 on housing construction activity proposed that for a quarrying or any other industry, there should be at least three kilometers (3,000 metres) from the site. However, due to the growth in population, a lot of housing has been built near quarries, with many negative impacts such as cracks in houses, broken roads, dirt and dust in the atmosphere, and noise from blasting (Ibrahim et al., 2019, p. 1).

Accordingly, a permanent prohibition on blasting within a minimum baseline 2,000-metre radius would better reflect the precautionary principle and cumulative risks posed by unrestricted, high-capacity, multi-hole detonations over the lifespan of a quarry. This locational constraint on the prohibition of blasting quarries is consistent with best practices in other jurisdictions, such as Muskoka Lake, Ontario (2,000 metres from lakes and rivers) (Township of Muskoka Lakes, 2023, p. 193) and Grundy County, Tennessee, (1,524 metres from sensitive land uses) (Sevelka, 2025). ARA's existing time-based restriction implicitly acknowledges the adverse effects of blasting, such as vibration, noise, flyrock, and structural amplification—yet it fails to address the spatial and temporal persistence of these impacts. Time-based restrictions regulate when blasting occurs, but not where its impacts persist; only spatial buffers can mitigate cumulative damage to receptors.

A permanent spatial buffer would enable receptor-based calibration, reinforce permanent municipal land use compatibility, and safeguard long-term community health, property values (Sevelka, 2022) and ecological integrity. The 1993 report by The Commission on Land Use and the Rural Environment, released by the New Brunswick government, acknowledges the "obnoxious" nature and significant adverse effects of pits and quarries, mainly experienced in relation to residential development, in addition to the aggregate industry's impact on the environment.

Activities that are essential in the operation of pits and quarries are often a cause of conflict. This is mainly because of the relatively obnoxious nature of this industry. Those conflicts are experienced primarily in relation to residential development. Sometimes the pit operation starts up beside an established house, while other times the house is constructed next to an existing pit. Other conflicts are less obvious, but just as real. They have to do with the proximity of pit and quarry operations to other

resources, such as agriculture or forestry. There are also times when the quality of the environment itself is affected by pit and quarry operations.

To people living near pit and quarry operations, the noise, dust, vibrations, [flyrock debris], operating hours, and safety factors are serious points of contention. Noise caused by operations themselves, from blasting, and from trucks can be very disturbing to residents living near a quarry. The sound of explosives and machinery, which are necessary for normal quarry operations, can be very disturbing to surrounding residential areas, but it can also affect sensitive wildlife species for kilometres around the site. Blasting and the resulting vibrations can cause damage to wells and foundations. The dust which is normally generated from excavation, blasting, screening, and crushing operations can have an impact on the health of humans, plants, and animals, as well as degrade the surface of dwellings and vehicles. The concerns for operating hours and public safety are most prevalent where blasting and heavy equipment are used, and with respect to abandoned operations in populated areas. The negative social impacts of such operations next to a residential area can affect property value, community lifestyle, and the general appearance of the neighbourhood (Government of New Brunswick, 1993, pp. 238-239).

The need for spatial buffers is further underscored by the absence of any evaluation of cumulative or long-term vibration exposure in legacy studies such as the U.S. Bureau of Mines, Report of Investigations 8507 (1980), which focused solely on discrete blast events. These studies fail to account for progressive fatigue, microfracturing, seal degradation, and settlement shifts that can result from repeated low-level vibration over time. Such impacts often manifest gradually, beyond the scope of short-term observation windows, and are especially relevant in rural and semi-rural zones where receptor redundancy is limited and structural resilience varies. Long-term vibration exposure can compromise foundation integrity, joint stability, and mechanical alignment, particularly in buildings with unreinforced masonry, riveted steel, or aging HVAC and plumbing systems. Compatibility studies that ignore cumulative exposure risk underrepresent non-visible damage, mischaracterize receptor vulnerability, and violate planning instruments such as PPS 2024 Section 1.2.6.1, which requires the permanent protection of sensitive land uses and infrastructure. These cumulative effects must be modelled and disclosed as part of any compatibility assessment, with monitoring protocols designed to detect sub-damage thresholds and progressive degradation over time.

In the abovementioned 1980 report by Siskind et al, the authors establish 0.5 in/sec (12.7 mm/s) as the "threshold" for damage to structures, and they define "threshold" as a 5% probability of cosmetic damage. The probability of damage to a home may be relatively small in any single blasting event. However, according to Dr. Kiger[6], numerous opportunities for an unlikely occurrence (like damage to the home) will result in a very likely occurrence of damage. For example, if the probability of damage (P_d) in any single blasting event is 0.05, or 5 percent, then the probability of not being damaged (P_u) is 95 percent. One can use the probability law of independent events to calculate the probability of damage occurring at least once in 100 events.[7] Thus, assuming the probability of damage is the same for each event, 0.05, then the probability of not being damaged at least once in 100 events is:

$$P_{u\text{-}100} = (0.95)^{100} = 0.006$$

And the probability of the structure being damaged in 100 explosions is 1 minus the probability that it is not damaged, thus:

$$P_{d\text{-}100} = 1 - 0.006 = 0.994$$

This implies that the probability of damage in 100 events is about 99 percent, meaning damage is almost certain if the homes are subjected to these blast-induced ground vibrations numerous times. Thus, even though damage is unlikely to result from any single blasting event, some damage in the form of cracking of walls, ceiling, tile, concrete, nail popping, loosening of framing joints, etc., becomes very likely over time with numerous repetitions of blast-induced ground vibrations. And once damage occurs (like cracking, nail pops, or framing joints loosening), that damage will rapidly increase with repeated exposure to the vibrations, even at lower levels of vibrations.

This concern was reinforced in *Chase Limited Partnership*, Case No. BA 95-58E (May 13, 2024)[8], where the tribunal rejected the petitioner's reliance on outdated science and noted the absence of any

[6] Dr. Kiger, January 19, 2015, Expert Report: Miller Paving Limited's quarry in the Municipality of McNab/Braeside, Ontario.

[7] See Henry L. Alder & Edward B. Roessler. *Introduction to Probability and Statistics* (3rd ed.). San Francisco: W.H. Freeman and Company, 1964.

[8] Howard County Board of Appeals Hearing Examiner. (2024). *Decision and Order in the Matter of Chase Land, LLC f/k/a Chase Limited Partnership*, Case No. BA 95-58E. Issued May 13, 2024. BA-95-058-DO.pdf

study examining the long-term effects of 20+ years of blasting on two-storey residential structures. The tribunal emphasized that "old science is not always good science," and that legacy studies like the 1984 U.S. Bureau of Mines report (RI 8896) were insufficient to dismiss cumulative damage claims. The tribunal emphasized the importance of cumulative impacts and receptor testimony from homeowners, noting that,

> Petitioner claims that because the homeowners are not geologists or are not familiar with the science of blasting or vibrations, they are not qualified to testify to their lived experiences. This is a fundamental misunderstanding of eye-witness testimony and, again, Petitioner's burden in this case. The record is replete with testimony from residents that they feel the blasts almost every week and that blast intensity has become greater over time. Residents also testified that they have seen things fall off their walls and their homes shake during a blast. There is no doubt they feel the blasts, and they have seen the damage to their properties increase over time (p. 23).

This decision underscores that homeowner receptor testimony and cumulative exposure evidence must be integrated into compatibility assessments, rather than dismissed through reliance on legacy Bureau of Mines criteria. This inferred acknowledgement is further reflected in the Municipality of East Ferris' 2023 settlement agreement with 1851477 Ontario Inc., which mandates advance notification to all property owners of developed or unimproved land within 2,000 metres of the quarry property line (not the excavation limit) before any blasting activity. This condition of the quarry expansion, embedded in the ARA licence[9], was negotiated through the municipal land use approval process and underscores the recognized need for proactive receptor engagement and localized impact mitigation through distance.

Two objectors to this quarry expansion described the impact on the community from a May 19, 2022, blast at the quarry up to two kilometres (2,000 metres) away:

> **"**On May 19, 2022, my house and a lot of others were shaken by a massive explosion that we never received any notice of. I live a mile from pitt [sic] and my house and garage shook massively. This is unacceptable. The noise pollution of this nature is not acceptable in this residential area. Working hard all day and coming home to this noise pollution isn't how I want to spend my summer" (Objector, June 30, 2022, https://ero.ontario.ca/comment/61187).
>
> "Degagne Carpentry has been trucking material out of this pit for over a month now. They completely disregarded the half-loading restrictions that were in effect till 15 May. Additionally, they have been blasting for over a week, with today, 19 May 2022, around 6:30 p.m., the blast being the biggest and providing no notice to the residents of Lavigne Rd. The blast shook houses 2 km away" (Objector, May 19, 2022, https://ero.ontario.ca/comment/61157).

The concept of "sensitive receptors" cannot be interpreted narrowly or in isolation. In land-use planning, it must be understood within the broader context of "sensitive land uses" under the policy framework of the *Provincial Planning Statement* (2024), The PPS provides the most authoritative and contemporary definition, situating sensitive receptors within the larger category of sensitive land uses, clarifying the types of activities and environments that require heightened protection from adverse effects. As the PPS explains:

> *Sensitive land uses:* means buildings, amenity areas, or outdoor spaces where routine or normal activities occurring at reasonably expected times would experience one or more adverse effects from contaminant discharges generated by a nearby major facility. Sensitive land uses may be a part of the natural or built environment. Examples may include, but are not limited to: residences, day care centres, and educational and health facilities (p. 51).

Importantly, ARA has no statutory authority to interfere with or authorize interference with the property rights of private third-party property owners or tenants, reinforcing the licensing limits of regulatory reach. All monitoring and testing equipment must remain on-site. Beyond the perimeter of the licensed area, land use, both onsite and offsite, is governed by the *Planning Act*, including the

[9] In 2023, Degagne Aggregates (1851477 Ontario Inc.) entered into an Agreement with the Municipality of East Ferris requiring advance notice of blasting to all landowners within 2 kilometres (2,000 metres) of the quarry property line. While this policy acknowledges the far-reaching effects of quarry operations—including noise, fugitive dust, toxic fumes, flyrock debris and structural impact—it does nothing to prevent or mitigate these health and environmental risks. This so-called "advance notice" offers no real protection. It does not safeguard homes, businesses or sensitive land uses from potential damage. Instead, it merely warns people to brace for impact—forcing residents and their pets into a cycle of uncertainty, disruption and anxiety every time explosives are detonated. Tenants and transient and mobile populations are excluded. This precedent underscores the need for receptor modelling that goes beyond notification and addresses actual risk mitigation through permanent land use compatibility.

Provincial Planning Statement (2024), municipal Official Plans and Zoning By-laws. This reinforces the limits of regulatory reach and the primacy of municipal control over receptor protection, land use compatibility, property rights, property values, and long-term community planning.

These findings align with international literature on quarry proximity and resident well-being, including Ibrahim (2019), which documents structural damage, airborne particulates, and acoustic disruption in communities adjacent to quarry operations. They also underscore the need for land use compatibility studies to incorporate both statutory receptor definitions and broader land use sensitivity criteria, calibrated to spatial and perceptual risk thresholds.

5. INADVERTENT STERILIZATION OF LAND POST-LICENCING

Once an aggregate licence is issued, especially in Ontario, where such licences have no expiry date and no limit on the depth of extraction, neighbouring vacant "as-of-right" and developed lands lose their functional potential and lawful right for development, expansion, or redevelopment because they are now deemed incompatible, inappropriate, or infeasible. These land use constraints, functionally equivalent to permanent easements, extend to both private and public lands. In effect, the use and enjoyment of these lands are curtailed, health, safety, and welfare are compromised, and the marketability and value of these lands are materially impaired for the duration of aggregate operations.

The costs associated with aggregate extraction are externalized, such as reduced development yield, impaired financing, or delayed approvals, with innocent third-party property owners bearing the financial burden, while the operator reaps the financial profits. Municipalities without adequate land use policies in place to prevent permanent land use incompatibility or land use planners lacking knowledge of receptor-based impact forecasting tools are ultimately responsible for undermining the long-term sustainability and economic viability of the community. This sterilization occurs not through formal downzoning, but through the operational reality that adjacent lands are now deemed incompatible with sensitive land uses such as residential, institutional, mixed-use development, or recreational. As Sevelka (2025) observes, Ontario's Aggregate Resources Act (Ontario Ministry of Natural Resources and Forestry, 1997) fails to coordinate effectively with the Planning Act, leaving municipalities without statutory tools to forecast or mitigate receptor sterilization. The absence of compatibility overlays, setback calibration, and receptor mapping allows aggregate operations to override local planning objectives, nullifying "as-of-right" permissions on adjacent lands and creating de facto takings without compensation.

This effect has been observed in the Township of Assiginack, where an owner of land adjoining a "zombie pit and quarry," which at the time of the severance request had not been operational for eight years, was denied a severance for the creation and sale of a building lot despite full compliance with local rural zoning and servicing standards, and absent any site-specific constraints (Sevelka, 2022; Sasvari, 2023).

6. STUDY DEFICIENCIES AND OMISSIONS

As such, RI 8507 cannot be used as a universal standard without structural, functional, and perceptual calibration aligned with Ontario's planning and environmental frameworks. The shortcomings and omissions of this outdated study are listed below:

- *Lack of property-owner consent protocols for monitoring equipment.* The 1980 study and related receptor monitoring practices do not address the legal requirement for property-owner consent before installing seismographs on third-party property. In Ontario and other common law jurisdictions, placing monitoring equipment or any other type of equipment on private property without explicit permission constitutes unlawful trespass under statute and established common law principles (e.g., intrusion upon land without consent),[10,11,12] undermining the legitimacy of vibration data and exposing operators to civil liability.

[10] Ontario Government (2020). *Security from Trespass and Protecting Food Safety Act, 2020, S.O. 2020, c. 9*. Security from Trespass and Protecting Food Safety Act, 2020, S.O. 2020, c. 9. Retrieved from: https://www.ontario.ca/laws/statute/20s09

[11] Government of Ontario (1990). *Trespass to Property Act,* R.S.O. 1990, c. T.21. Trespass to Property Act, R.S.O. 1990, c. T.21. Retrieved from: https://www.ontario.ca/laws/statute/90t21

[12] *Pattison v. McGinley Bros Inc. et al.*, 2023 ONSC 1393 (CanLII), affirms that trespass to land is actionable per se: *"a person who enters onto another's land without permission commits a trespass, even if no damage is caused."* The Ontario Superior Court of Justice granted a permanent injunction, holding that continued unauthorized use of the plaintiff's property—including physical

- *Inadequate measures for documenting vibration damage.* The 1980 study did not employ instrumentation capable of detecting microfractures or cumulative fatigue, relying instead on visual inspections and seismographic PPV readings. While technologies such as ultrasonic testing and acoustic emission monitoring existed at the time, they were not integrated, limiting the study's diagnostic relevance for assessing long-term structural integrity under repeated blasting exposure. These diagnostic tools are costly and require specialized training to operate and interpret.
- *Geomechanical discontinuities and wave reflection complexity.* The 1980 study assumes that vibration waves travel through solid rock in a uniform and predictable way. However, in reality, the rock between a blast site and a structure is often fractured, layered, or previously disturbed by earlier blasts. These natural and man-made breaks—called discontinuities—can weaken and scatter vibration waves, changing their direction and strength (Hudson, 1981; Kikuchi, 1981), and may amplify vibration in specific directions depending on subsurface geometry and blast orientation. Field studies confirm that local geology, including fractured strata and bedding planes, can significantly alter vibration transmission (Reil, 1985). In addition, the act of fracturing the rock during blasting creates new waves after each blast (detonation of each blast hole) that interact with each other in complex ways, sometimes making the vibrations stronger in certain areas (Achenbach, 1984; Rice, 1980). When these waves encounter open surfaces such as quarry walls or tunnel faces, they reflect in multiple directions, producing both up-and-down waves (compressional or P-waves) and side-to-side waves (shear or S-waves). The angles and magnitudes of these reflections depend on the angle of incidence and the wave velocities of the surrounding rock (Aki and Richards, 1980; Rinehart, 1975). Furthermore, when body waves reach the ground surface, they generate surface waves, primarily rolling waves called Rayleigh waves (R), which travel along the earth's surface in a motion that combines vertical and horizontal displacement, allowing them to bend around physical barriers and carry damaging energy along the surface (McLaughlin et al., 2004). These waves are particularly damaging to shallow foundations, finished basements, and sub-flooring systems, as they can amplify structural response and perceptual discomfort near receptors. These interactions can also change wave types, for example, from P-waves to S-waves or Rayleigh waves, and shift vibration frequencies, increasing the risk of resonance in mechanical systems and building finishes. Without accounting for these propagation complexities, damage attribution becomes unreliable — especially in concealed or resonance-sensitive areas — where strain energy may concentrate unpredictably. None of these effects are considered in the 1980 study, which limits its applicability in geologically complex or previously disturbed environments and undermines its compatibility with receptor-specific modelling frameworks such as those outlined in NS 8141-1+A2 and Ontario's Provincial Planning Statement (PPS), which requires land use decisions to consider actual impacts on sensitive receptors in the context of sensitive land uses—not just distance.
- *Lack of temporal granularity.* The study limits the ability to correlate blast timing with seasonal soil conditions, weather events, or structural fatigue progression, which can significantly affect wave propagation, amplification, and structural response. Without time-resolved data, it cannot account for variations in soil moisture, freeze-thaw cycles, or meteorological shifts that affect subsurface elasticity and damping. Moreover, the subsurface conditions between a given blast site and each receptor-type are unknowable without site-specific geotechnical modelling, further limiting the applicability of the findings to regionally specific planning contexts.
- *Absence of site-specific logs.* The study does not document the structural, geotechnical, or environmental characteristics of individual receptors, undermining reproducibility and receptor-specific calibration. This omission is especially problematic in Ontario, where freeze-thaw cycles, high-water tables, and heritage overlays materially influence vibration response. Without receptor-level documentation, it is impossible to establish tailored thresholds or conduct compatibility assessments under planning frameworks that require site-specific analysis.
- *Ambiguity in the definition of "cosmetic damage."* The report established 0.5 in/sec (12.7 mm/s) as the threshold for cosmetic damage, with a 5% probability per event. However, the term "cosmetic" was never formally defined, whether superficial (e.g., drywall cracks) or indicative of deeper structural compromise. The study documented cracking in plaster and gypsum board walls

intrusion by persons or objects—was sufficient to justify equitable relief and punitive damages. Retrieved from: https://canlii.ca/t/jwkdg.

but did not distinguish between aesthetic and functional damage. Moreover, the report did not consider damage to home contents such as artwork, framed photographs, mirrors, ceramics, family heirlooms, chinaware, crystalware, or electronics—items that may be sensitive to micro-movements, wall flexure, or particulate migration. These losses are rarely captured in structural assessments yet carry significant financial, emotional, and disclosure implications. Their exclusion further undermines the reliability of the cosmetic damage threshold and its applicability to real-world receptor conditions.

- *Lack of disclosure regarding structural characteristics.* The study monitored 76 residential structures, but did not disclose their quality of construction, age, size, footprint, or internal layout. This omission limits the applicability of its findings to regionally specific building stock, which may differ in construction methods, code compliance, and structural configuration, in jurisdictions such as Ontario, where building age, code evolution, and heritage overlays significantly influence vibration response. Ontario had no unified building code before 1975, and construction quality varies widely from dwelling to dwelling in semi-rural and rural settlement areas.
- *No evaluation of wells, septic systems, or site improvements.* The study excluded hydrogeological monitoring and did not assess vibration effects on groundwater flow, well integrity, septic fields, driveways, walkways, retaining walls, swimming pools, outbuildings, exterior sump pumps, propane tanks, or outdoor cisterns—despite their vulnerability in rural and semi-rural settlement areas. These features are often unreinforced or legacy installations sensitive to micro-movements, soil displacement, or structural fatigue. Propane tanks, in particular, may be subject to anchoring stress, line misalignment, or valve disruption under vibration exposure. Their omission limits the study's applicability to receptor types common in Ontario's rural and semi-rural settlement planning contexts, where unreinforced or legacy infrastructure is common and particularly vulnerable to vibration-induced stress.
- *No assessment of renewable energy infrastructure.* The study did not evaluate impacts on rooftop solar panels, ground-mounted arrays, battery storage units, or geothermal boreholes. These systems are increasingly common in rural and semi-rural Ontario and may be sensitive to vibration-induced microfractures, grout seal failure, or mounting fatigue. Additionally, the study did not consider dust migration or particulate deposition resulting from blasting activities. Fine particulate matter can accumulate on solar panels, reducing energy yield and requiring more frequent cleaning. Dust infiltration may also affect battery enclosures, inverters, and geothermal manifolds—compromising performance, longevity, and safety (Nezamisavojbolaghi et al., 2023). These disruptions lead to increased maintenance frequency, premature component failure, and elevated replacement costs. These impacts reduce system lifespan and return on investment for property owners and small-scale operators (Geetha et al., 2025).
- *No consideration of heritage structures.* The study did not assess impacts on historic buildings, heritage-designated structures, or monuments, which may be more vulnerable to vibration due to aged materials, mortar fatigue, and preservation constraints. This omission is critical in jurisdictions like Caledon, where cultural heritage assets are protected under municipal and provincial planning frameworks.[13] Section 2.6 of the Provincial Planning Statement (PPS 2024) affirms that cultural heritage resources must be identified, conserved, and protected during land use planning and development. This includes built heritage resources, cultural heritage landscapes, and archaeological sites—especially in municipalities like Caledon with active heritage conservation policies.

PPS 2024 – Section 2.6: Cultural Heritage Resources: Key Provisions

- 2.6.1: Significant built heritage resources and significant cultural heritage landscapes shall be conserved.
- 2.6.2: "Development and site alteration shall not be permitted on lands containing archaeological resources or areas of archaeological potential unless significant archaeological resources have been conserved."

[13] GoodLot Farmstead Brewing Co. (n.d.). *GoodLot Farmstead Brewing Co.* Retrieved November 28, 2025, from https://www.goodlot.beer/

- 2.6.3: Development and site alteration shall not be permitted on adjacent lands to protected heritage property except where it has been demonstrated that the heritage attributes of the protected heritage property will be conserved.
  These provisions are binding under the Planning Act and apply to all municipalities in Ontario. They require that vibration impacts on heritage structures be assessed and mitigated, especially where aged materials, mortar fatigue, or preservation constraints may heighten vulnerability.
- *Exclusion of agriculture and recreational outbuildings, and public-use receptors.* The study fails to assess a broad class of vibration-sensitive structures commonly found within the 2,000-metre blast radius of the Votorantim Cimentos (St Marys/CBM) quarry application proposed quarry site in Caledon, including legacy stone foundations, heritage-grade structures, and seasonal tourism infrastructure such as barns, greenhouses, root cellars, chicken coops, animal shelters, seasonal bunkhouses and cabins, detached garages, sheds, cabanas, outdoor theatres, gazebos, bandstands, outdoor kitchens, BBQ shelters, rest stations, public washrooms, trailhead kiosks, and interpretive shelters. These structures—often slab-mounted, post-set, or lightly framed—are prevalent in rural and semi-rural settlement areas with mixed-use zoning and legacy construction practices. Their structural characteristics make them particularly vulnerable to cumulative vibration impacts such as anchoring fatigue, frame distortion, panel displacement, and slab cracking. The exclusion of these receptors not only undermines statutory compliance but also compromises the integrity of land use compatibility modelling, emergency response planning, and rural service continuity. These receptors often co-locate near or in rural hamlets and ecological corridors, where cumulative exposure to vibration, overpressure, and emergency response delays poses heightened risk to public safety, infrastructure integrity, and ecological continuity. These omissions materially affect receptor mapping within 2,000 metres, setback modelling, and mitigation planning required under PPS 2024 and the Caledon Official Plan. Structures located within 500 metres of the proposed blast radius face heightened exposure to vibration, overpressure, and infrastructure fatigue.
  The following site-specific examples illustrate the range and vulnerability of receptors (sensitive land uses) omitted from the blast impact assessment:
- *Alton Greenhouses & Garden Centre (19598 Main Street, Village of Alton)*[14] – commercial greenhouse with slab-mounted display shelters and public access.
- *Forks of the Credit Provincial Park (17760 McLaren Road, main entrance)*[15] – within 500 metres of the proposed quarry boundary, – public-use washrooms, rest stations, interpretive shelters, and the ruins of the Cataract Electric Company hydro generating plant, a legacy stone and concrete structure adjacent to the Credit River and former Brampton Railway corridor; qualifies as a vibration-sensitive receptor and potential cultural heritage resource under PPS 2024 Policy 2.6 and the Ontario Heritage Act Section 27.
- *Credit Valley Conservation (CVC) lands* – community gardens, tool sheds, and seasonal infrastructure.
- *TPC Toronto at Osprey Valley Golf Course (18821 Main Street)*[16] – nationally recognized golf and hospitality complex comprising three championship courses, overnight accommodation villas, four golf simulators, two licensed restaurants with seating capacity for approximately 130 patrons, and multiple hospitality outbuildings. The facility also hosts PGA TOUR events, including the RBC Canadian Open, with modular grandstand seating, outdoor kitchens, and event structures. These structures are slab-mounted, lightly framed, or modular and, therefore, structurally vulnerable to vibration amplification, anchoring fatigue, and displacement. Located within 100 metres of the proposed quarry boundary, the property qualifies as a vibration-sensitive public-use receptor under PPS 2024 Policy 2.4.4 and Caledon Official Plan Section 3.1 due to continuous public occupancy, tourism infrastructure, and its role as a regional cultural and economic asset.
- *Credit Valley Trail (Orangeville to Lake Ontario in Mississauga)* – within 300 metres of the proposed quarry boundary, former Brampton Railway corridor with trailhead kiosks, signage, and

[14] Alton Greenhouses & Garden Centre. (n.d.). *Alton Greenhouses & Garden Centre*. Retrieved November 28, 2025, from https://altongreenhouses.ca/

[15] Ontario Provincial Parks. (n.d.). *Forks of the Credit Provincial Park*. Retrieved November 28, 2025, from https://ontarioprovincialparks.ca/park/forks-of-the-credit-provincial-park/

[16] TPC Toronto at Osprey Valley. (2024). *Facilities and venues overview*. Retrieved November 29, 2025, from https://www.ospreyvalley.com/

legacy rail infrastructure, and active culvert and bridge upgrades, forms part of CVC's long-term ecological corridor and proposed parkland integration strategy[17].

- *GoodLot Farmstead Brewing Co. (18825 Shaws Creek Road)*[18] – slab-mounted brewery outbuildings, beer garden shelters, and public-use facilities.
- *Chickadee Hill Farm* – legacy agricultural outbuildings including barns, chicken coops, apiary sheds, tool and feed storage sheds, a slab-mounted farm-gate retail shelter, and a historic stone foundation qualifying as a potential cultural heritage resource.
- *Esso Gas Bar Mixed-Use Commercial and Residential (1521 Charleston Sideroad SE corner Charleston Sideroad and Cataract Road/Main Street)* - comprising a slab-mounted fuel station with four dispenser pumps, a public-facing convenience store, and upper-level residential occupancy. Located at a rural hamlet intersection, within 20 metres of the lot limits of Votorantim Cimentos' (St Marys/CBM) application for a blasting quarry and processing plant, the site includes flammable inventory, buried tanks, pressurized systems, a commercial propane tank, and continuous public access. The convenience store, LCBO outlet, Beer Store, 26-seat licensed restaurant, and two-bay auto repair shop add retail foot traffic, glass shelving, and public queuing exposure. Its slab-on-grade construction, light framing, and multi-interface occupancy make it structurally and functionally vulnerable to cumulative vibration and overpressure impacts. There are also four U-Haul truck rentals. Qualifies as a vibration-sensitive public-use receptor under PPS 2024 Policy 2.4.4 and Caledon Official Plan Section 3.1 due to mixed-use zoning, receptor sensitivity, and role in supporting rural service infrastructure.
- *The Liberty Inn – Heritage Hospitality and Arts Retreat (14938 Cataract Road, Hamlet of Cataract)*[19] – Constructed in 1855, this legacy stone and brick building is one of the oldest continuously occupied mixed-use structures in Ontario. Originally serving as Cataract's first post office and general store, it now operates as a Nordic spa and boutique retreat offering overnight accommodation, pottery workshops led by a professional ceramicist, and outdoor wellness programming including forest bathing, seasonal rituals, and private use of a woodland-set Nordic spa. The site includes a dug stone foundation, slab-on-grade additions, and vibration-sensitive pottery infrastructure such as kilns, wheels, and shelving. These features are structurally vulnerable to anchoring fatigue, thermal instability, and displacement. Located within 400 metres of the proposed blast zone, the property qualifies as a vibration-sensitive public-use receptor under PPS 2024 Policy 2.4.4 and Caledon Official Plan Section 3.1 due to its heritage construction, cultural programming, seasonal public occupancy, and role in supporting rural wellness and arts-based tourism. The structure and original civic function also trigger obligations under PPS 2024 Policy 2.6 and the Ontario Heritage Act Section 27 as a potential cultural heritage resource.

  These omissions compromise the integrity of receptor mapping and setback modelling required for compatibility analysis under PPS 2024 and the Caledon Official Plan, materially limiting the study's applicability to Caledon's rural planning context and fails to meet the compatibility and mitigation requirements of PPS 2024 Policy 2.4.4, which mandates that major facilities such as quarries be planned and buffered to prevent or mitigate adverse effects on sensitive land uses, and Caledon Official Plan, which requires site-specific compatibility studies and mitigation measures for mineral aggregate operations. In the case of Chickadee Hill Farm, additional obligations may arise under PPS 2024 Policy 2.6 and the Ontario Heritage Act Section 27, due to the presence of a historic stone foundation.

  Moreover, this exclusion undermines the broader sustainability objectives outlined in Caledon Official Plan Section 3.1, which require development proposals to demonstrate how they contribute to long-term community health, ecological integrity, and rural resilience. Section 3.1 emphasizes precautionary planning and the protection of sensitive receptors — including built heritage and agricultural assets — as part of Caledon's integrated approach to environmental, economic, and social sustainability. The omission fails to account for these receptors and represents a material planning deficiency and increases the risk of unmitigated structural damage, ecological disruption, and civil liability.

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[17] Credit Valley Trail

[18] GoodLot Farmstead Brewing Co. (n.d.). *GoodLot Farmstead Brewing Co.* Retrieved November 28, 2025, from https://www.goodlot.beer/

[19] The Liberty Inn. (n.d.). *The Liberty Inn*. Retrieved November 28, 2025, from https://www.thelibertyinn.ca/

- *Failure to account for finished basements and damage concealment.* Finished basements conceal structural elements — such as foundation walls, floor slabs, and load-bearing joints — behind drywall, paneling, flooring, and ceiling treatments. This limits visibility and access during pre- and post-blast inspections, potentially masking vibration-induced cracking, separation, or fatigue. The absence of a standardized protocol for assessing finished spaces undermines the reliability of damage attribution and complicates post-event diagnostics, especially in jurisdictions where basement finishing is common and variable in quality. Moreover, vibration-induced fissures or joint separations may allow water ingress, particularly in areas with high water tables or seasonal runoff. In finished basements, this can lead to trapped moisture behind impermeable surfaces, fostering mold growth—including *Stachybotrys chartarum* (black mold)—which poses serious health risks and may require costly remediation (Shoemaker et al, 2025). These risks are amplified when basement finishing is completed without permits or moisture barriers, further obscuring liability and complicating insurance and public health responses. Sub-flooring systems (e.g., plywood, OSB, sleeper frames, or floating panels) installed over concrete slabs further obscure direct access to structural surfaces and introduce additional diagnostic blind spots. Vibration-induced damage may propagate beneath these systems undetected, especially when no vapor barrier is present. Sub-flooring also creates air gaps and impermeable layers that trap moisture from hydrostatic pressure or seasonal runoff, increasing the risk of anaerobic mold growth and microbial colonization. These risks are amplified when basement finishing is completed without permits, inspections, or moisture protection, further obscuring liability and complicating insurance and public health responses. Certain sub-flooring designs may also amplify vibration resonance, increasing perceptual discomfort and secondary damage to finishes. These factors must be explicitly considered in compatibility modelling, damage attribution protocols, and pre-blast survey frameworks.
- *No consideration of psychological or quality-of-life impacts.* The Siskind study did not account for perceptual or psychological effects, which were central to the Alvaton[20] denial and are increasingly recognized in receptor vulnerability modelling. It also lacked a damage attribution protocol, creating ambiguity in enforcement and undermining compensation mechanisms. Complaints, fear, disturbances, and other human reactions to vibration from construction work, especially blasting activities, are likely to occur at much lower vibration levels than those causing building damage. In Norway, vibration class limits for land-based transport under standard NS 8176 [10] are in the range of 0.1 mm/s to 0.6 mm/s. These thresholds are sometimes applied to quarry blasting and similar activities (Turunen-Rindel et al., 2017), reflecting a more precautionary approach to receptor sensitivity and perceptual comfort. NS 8141-1:2012+A2:2014 is a Norwegian standard that sets guideline limit values for vibration and airblast from construction, mining, and traffic. Amendment A2 was added to address human reactions, not just structural integrity — recognizing that perceptual impacts such as annoyance, fear or anxiety, and sleep disruption require distinct thresholds and land use planning consideration (Standard Norge, 2014).
  Human response to ground vibrations is addressed in the Siskind et al. 1980 report on page 4. On page 62 of the report, the authors indicate: “Responses of ‘slightly perceptible’ occurred at 0.010 in/sec [0.25 mm/sec] to 0.033 in/sec [0.84 mm/sec], and the threshold of ‘strongly perceptible’ is 0.10 in/sec [2.54 mm/sec].” The authors go on in the next paragraph to define “strongly perceptible” as “unpleasant”.
  These thresholds and perceptual quality of life criteria must inform land use compatibility modelling under PPS 2024 Policy 2.4.4 and Caledon Official Plan Section 3.1, especially where receptors include heritage assets, seasonal dwellings, and public-use infrastructure.
- *No evaluation of cumulative or long-term vibration exposure.* The 1980 study (RI 8507) focused on discrete blast events and did not assess the effects of repeated low-level vibration over time,

[20] On October 23, 2018, the Meriwether County Board of Commissioners (CBC) denied the request to rezone the property and grant a special use permit for a blasting quarry. The appeal of the CBC ruling to deny the rezoning was upheld by the Superior Court in *Luther H. Randall, lll, et al., v. Meriwether County, Georgia, et al.* File No. 18CV0270 [May 1, 2019]. In upholding the decision of the Board of Commissioners, the Superior Court made a number of observations as to the significant potential adverse impacts, including the following: “(e) blasting at the quarry has a high likelihood of damaging many of the more than 100 residential structures within one to two miles [1.609 to 3.219 kilometres] of the proposed granite pits over the life of the proposed operation and will significantly degrade the quality of life for those residents affected; [p. 9-11].” https://flintriverkeeper.org/wp-content/uploads/2019/05/Randall_etal_v_Meriwether_County_etal_Final_Order.pdf.

which can lead to progressive fatigue, microfracturing, seal degradation, and settlement shifts in both structural and mechanical systems. These impacts often manifest gradually, beyond the scope of short-term observation windows, and are especially relevant in rural and semi-rural zones where receptor redundancy is limited and structural resilience varies. Long-term vibration exposure can compromise foundation integrity, joint stability, and mechanical alignment, particularly in buildings with unreinforced masonry, riveted steel, or aging HVAC and plumbing systems. Compatibility studies that ignore cumulative exposure risk underestimating non-visible damage, misrepresenting receptor vulnerability, and violating planning instruments such as PPS 2024 Section 1.2.6.1, which require permanent protection of sensitive land uses and infrastructure. A modernized framework must incorporate high-cycle fatigue modelling, frequency-specific calibration, and longitudinal monitoring to ensure compatibility with both human and non-human receptors over time. These cumulative effects must be modelled and disclosed as part of any compatibility assessment, with monitoring protocols designed to detect sub-damage thresholds and progressive degradation over time. As noted in *Chase Limited Partnership*, Case No. BA 95-58E, May 13, 2024 (Standard Norge, 2014):[21]

Petitioner claims that it is scientifically impossible for Chase Land to have caused the damages alleged by homeowners. This is plainly false, as that fact has not been proven either by the scientific community or in this case. The petitioner has not produced a single study scientifically examining the long-term and cumulative effects of over 20 years of blasting on two-story residential structures. The petitioner's own expert, Mr. Rudenko, was not aware of any studies conducted over the past 20 years to determine the cumulative effects of blasting. In support of Petitioner's theory that it is not in violation of Condition 13, Petitioner's witnesses cite a 1984 U.S. Bureau of Mines study that attempts to model what nearby homes might look like after 20+ years of blasting at a coal mine. The study was conducted for only 2 years, and not 20 years. The Opposition's homes have been the recipients of the blasts and vibrations (Stagg et al., 1984). Petitioner's witness cites Galileo's formula for the acceleration to bolster their argument that their extremely old data is scientifically sound. By Petitioner's logic, smoking does not cause lung cancer because there was no scientific proof of that in the early 1600s. Old science is not always good science.

- *Exclusion of indoor mechanical, environmental, and occupancy-related systems.* The 1980 study (*RI 8507*) did not evaluate vibration impacts on HVAC systems, water heaters, sump pumps, electrical panels, or ductwork — nor did it account for appliances, mounted fixtures, or sensor-based systems such as thermostats, alarms, and automated controls. These components are vulnerable to vibration-induced alignment shifts, joint fatigue, seal degradation, and operational disruption — even in the absence of visible structural damage. The 1984 study (*RI 8896*) involved a single unoccupied, raised wood-frame bungalow with an unfinished concrete block basement, equipped with electricity and heating/cooling systems but lacking plumbing and interior finish work such as doors, cabinetry, and furnishings. The absence of these occupancy-related systems and loads eliminated key vibration transmission pathways and resonance amplifiers found in real-world residential or mixed-use receptors. These exclusions further limit the diagnostic relevance of both studies for licensing decisions involving occupied, mechanically integrated, or receptor-diverse environments.

  Moreover, the foundational studies by David Siskind have been repeatedly criticized and dismissed by explosives experts and courts. FOIA correspondence reveals that a senior Vibra-Tech official—representing a leading blasting technology firm—warned:

  > "Any criteria…which ignores the frequency of a structure and the frequency content of the ground motion is overly simplistic…Your criteria, as proposed, will neither protect the interests of the citizen and the homeowner nor will it protect the blaster from alleged damage claims.

  After the Bureau of Mines was defunded in 1995 by Congress, Siskind became a private consultant and testified for the coal company that lost the Bim case, a landmark decision that overturned his vibration limits. As Siskind himself admitted in a 1997 letter to an OSM (Office of Surface Mining Reclamation and Enforcement) official:

[21] Howard County Board of Appeals Hearing Examiner. (2024). *Decision and Order in the Matter of Chase Land, LLC f/k/a Chase Limited Partnership*, Case No. BA 95-58E. Issued May 13, 2024. Retrieved from: https://baltimorepostexaminer.com/wp-content/uploads/2024/06/BA-95-058-DO.pdf

> "Complainants are trying to dismiss all the science as biased, wrong, or non-applicable. For the most part, they are succeeding in ways that pay off (Loeb, 2000)."

These admissions and legal outcomes further undermine the credibility of RI 8507 and RI 8896 as reliable diagnostic tools for receptor compatibility in Ontario quarry licensing, particularly in occupied and furnished, mechanically integrated, or receptor-diverse environments where vibration impacts extend beyond visible structural damage.

- *No assessment of accessibility features or mobility aids.* Vibration-induced misalignment of ramps, lifts, grab bars, or door thresholds can pose safety risks, particularly in homes with aging residents or accessibility retrofits. These features are often installed in older structures with variable anchoring conditions and may be sensitive to micro-movements or wall flexure. As of mid-2024, approximately 11,446 Caledon residents are aged 65 and over—representing about 12.6% of the town's population. Their presence reinforces the need for compatibility analysis that includes accessibility infrastructure and receptor-specific calibration. Age-friendly planning is addressed in the PPS (2024) under Section 2.1.1(d), which calls for land use patterns that support aging in place and barrier-free access.
- *No evaluation of indoor air quality or dust migration.* The study did not assess how vibration may dislodge settled dust, degraded insulation fibers, or aged building materials such as plaster, lead paint, or asbestos-containing compounds. These particulates can become airborne and circulate through HVAC systems, especially in finished basements or older homes with limited ventilation. This can degrade indoor air quality, trigger respiratory irritation, and compromise filtration systems. In Ontario's rural and semi-rural settlement areas—where basement finishing is common, and ventilation varies—these risks are amplified. The absence of indoor air quality modelling or dust mitigation protocols undermines compatibility analysis under Ontario's planning frameworks, particularly where receptor vulnerability includes children, seniors, or individuals with respiratory sensitivities.
- *No consideration of insurance, disclosure, or real estate impacts.* Even "cosmetic" damage can trigger insurance claims, affect resale value, or require disclosure under real estate regulations. The absence of a standardized damage attribution protocol complicates these processes and disadvantages property owners and tenants. For landlords, vibration-related damage may affect unit turnover, rental income, and insurability, while tenants may experience disruption, loss of quiet enjoyment, or damage to personal property not covered under standard renter's insurance. Moreover, vibration can damage contents such as artwork, framed photographs, sentimental keepsakes, ceramics, and electronics—items sensitive to micro-movements, wall flexure, or particulate migration. These losses are not addressed in structural assessments, yet they carry significant financial and emotional value. They are typically excluded from standard homeowner and renter policies without specific riders, leaving both landlords and tenants exposed. Their vulnerability reinforces the need for receptor-specific calibration under Ontario's Planning framework and land use compatibility study requirements, as outlined in Section 1.2.6.1 of the Provincial Policy Statement, 2024 and the Real Estate Council of Ontario's Material Fact Disclosure bulletin, which requires registrants to disclose any known condition that could reasonably affect a buyer's or tenant's decision (RECO, 2023).
- *No assessment of vibration impacts on animals or livestock.* These disturbances can cause behavioural changes, physiological stress, and disruption to pets, livestock, and wildlife—receptors that are especially relevant in rural, rural settlement, agricultural, and conservation contexts. As Reynolds et al. (2020, p. 159) note, "Sound and vibration have been shown to alter animal behavior and induce physiological changes as well as to cause effects at the cellular and molecular level". Sevelka (2023) further documents cumulative stress responses in domestic and wild animals near quarry operations, reinforcing the need for non-human receptor calibration. This is particularly significant given that almost 80% of Canadian households own at least one pet, with ownership rates even higher in rural and semi-rural areas due to larger property sizes, agricultural uses, and cultural norms around animal companionship and utility (Made in CA, 2025). While Caledon's Animal Care and Control By-law No. 2019-43 (Town of Caledon, 2019) regulates the treatment and control of animals within the municipality, compatibility studies rarely incorporate vibration-related welfare risks. This omission undermines ecological planning principles and municipal animal protection standards, particularly in zones permitting kennels, livestock operations, or

adjacent to Environmental Policy Areas. Receptor-specific calibration is required under Ontario's Planning framework to ensure compatibility with both human and non-human receptors.

- *No evaluation of telecommunications or digital infrastructure.* Sensitive equipment such as routers, servers, smart devices, and antennae may be disrupted by vibration, particularly in areas with limited redundancy or aging infrastructure. This is increasingly relevant in rural and semi-rural communities where remote work, digital education, and telehealth services depend on stable connectivity. According to Innovation, Science and Economic Development Canada's *Connectivity Strategy*, internet access is no longer a luxury but a critical utility for economic participation, education, and healthcare delivery (Innovation, Science and Economic Development Canada, 2025; Office of the Auditor General of Canada, 2023). Vibration can interfere with signal transmission, destabilize mounted hardware, and degrade performance in systems reliant on precise calibration or uninterrupted power. These risks are rarely addressed in compatibility studies, despite the growing reliance on fixed wireless, satellite, and antenna-based systems in rural and semi-rural Ontario. Their omission undermines digital equity goals and exposes receptors to service disruption, data loss, and equipment failure—especially in zones with limited broadband redundancy or emergency response infrastructure.
- *No evaluation of sensitive non-residential uses.* The study did not evaluate vibration impacts on non-residential uses such as those permitted "as-of-right" under Caledon's Zoning By-law No. 2006-50 (Town of Caledon, 2023) or as small-scale uses, subject to a Development Permit, in Minor Urban Centres under the Niagara Escarpment Plan, such as medical diagnostic equipment, 3D printing, art galleries/studios, yoga studios, message therapy, hair salons and barber shops, fitness instruction, daycare centres, pet grooming (non-kennel), recording studios, computer repair, jewelry making, photography, and tutoring. These uses, categorically summarized in the matrix below, are increasingly present in rural and semi-rural settlement areas and may be highly susceptible to vibration-induced disruption, even below structural damage thresholds.

Table 2: Vibration-Sensitive Uses Matrix – Caledon & NEP Minor Urban Centres

Use Type	*Examples*	*Caledon Zoning (As-of-Right)*	*NEP Centres (Permit Required)*	*Sensitivity*	*Diagnostic Challenges*
Health & Wellness	Massage, physio, counselling, speech therapy	Permitted	Permitted	High – client comfort	Concealed damage, perceptual effects
Creative & Instructional	Art, music, yoga, tutoring, photography	Permitted	Permitted	Moderate – High - focus	Subjective impacts, misalignment
Personal Services	Hair, esthetics, pet, grooming, tattooing	Permitted	Permitted	Moderate – tools, safety	Equipment fatigue, client discomfort
Tech & Precision Work	3D printing, electronics, jewelry making	Permitted	Permitted	High - calibration	Microfractures, miscalibration
Education & Online	Virtual teaching, test prep, tutoring	Permitted	Permitted	Moderate – AV quality	Tech interference, focus disruption
Small-Scale Production	Baking, tailoring, crafts, and antiques retail	Permitted	Permitted	Moderate - inventory	Cracking, dust, display damage

Audio/Recording	Studios, podcasting, mastering	Permitted	Permitted	High-acoustic fidelity	Audio distortion, equipment drift

These uses in table 2 are protected under Ontario's planning frameworks and must be considered in land use compatibility assessments under the *Planning Act*, *PPS* (2024), and *Niagara Escarpment Plan*. Their exclusion from RI 8507 and Golder's assessment undermines diagnostic completeness and planning integrity.

7. BLASTING PEAK PARTICLE VELOCITY (PPV) LIMITS IN OTHER JURISDICTIONS

In recognition of the fact that damage to dwellings can occur at low ground vibration levels, other countries have set much more stringent limits on allowable peak ground vibrations. Table 2 below shows that regulatory agencies in Leicestershire County, UK have established the upper limit on allowable peak particle velocity as 0.24 in/sec (6.096 mm/sec); in Australia the common limit is 0.2 in/sec (5.08 mm/sec) and it is 0.008 in/sec (0.00254 mm/sec) for historical buildings and monuments for frequencies less than 15 Hz (Australian and New Zealand Environmental Council, 1990)[22,23]. These have been described in table 3 below.

Table 3: Typical blasting limits by country (source: Roy, 2005)

Measure	*Units*	*Comments*
Human perception	0.15 – 1.5 mm/s	
Visible damage	50 mm/s	Values in excess cause appreciable structural damage
British Standard BS 64722.1922	8.5 – 12.7 mm/s	90 % confidence limit – permissible impulsive vibration at residential property
Leicestershire County Council (UK)	6 mm/s	90 % confidence level – part of the conditions covering blasting within modern planning permissions
Australian Standard Explosive Code AS2187-1993	5 mm/s	Common environmental limit (EPA) – depends on the administering authority
(AS2187.2-2006)	0.2 mm/s	Historical buildings and monuments – displacement for frequencies less than 15 Hz
	19 mm/s	Houses and low-rise residential buildings – resultant PPV for frequencies greater than 15 Hz
	25 mm/s	Commercial limit AS 2187.3
India	5 mm/s	Domestic house/structures – frequencies less than 8 Hz
German Standard DIN 4150 (GIS, 1986)	5 mm/s	Domestic house/structures – frequencies less than 10 Hz
	5 -15 mm/s	Domestic house/structures – frequencies 20 to 40 Hz
	15 – 20 mm/s	Domestic house/structures – frequencies 50 to 100 Hz
Hungarian Standard	5 mm/s	Panel houses
Swiss Standard	8 – 12 mm/s	Objects of historic interest or other sensitive structures – frequency bandwidth: 60 – 90 Hz
Swedish Standard National Museums	12 mm/s	Building structure
	5 mm/s	Sensitive exhibits

[22] Miller Paving Limited's (Miller) quarry located in the Municipality of McNab/Braeside, Ontario: Dr. Kiger's Expert Report prepared January 12, 2015.

[23] *Table 2* from R. Pesch and A. Robertson, "Drilling and Blasting for Underground Space", Wollongong, NSW, 3 – 4, September 2007 at p. 190. Drilling and Blasting for Underground Space – 20070925041722.s

8. CONCLUSION

RI 8507 remains a historically significant study, but its lack of methodological rigour, lack of receptor diversity, and lack of temporal granularity render it inadequate as a universal standard for vibration impact assessment. Its continued use in the United States and other jurisdictions, including Ontario quarry proposals — without receptor-specific calibration — risks misrepresentation of environmental impacts and undermines public trust, legal defensibility, and planning integrity. A modernized framework must incorporate structural diversity, perceptual sensitivity, frequency-specific modelling, and environmental context. This includes recognition of mechanical system vulnerability to resonance effects, persistent, perpetual discomfort, and emotional distress at sub-damage vibration levels, and ecological receptor sensitivity. These considerations must be aligned with Ontario's planning instruments and ecological realities, and internationally recognized standards such as NS 8141-1+A2 and NS 8178 (Norway).

To operationalize permanent land use compatibility and enforce perimeter-based monitoring, all receptors within a minimum baseline 2,000-metre radius of the boundary limits of Votorantim Cimentos' (St Marys/CBM) application for a blasting quarry and processing plant, and abutting ownership or potential control must be identified, classified, and mapped using current parcel data. This inventory must include a complete physical description, including land use controls and land use overlays for each parcel. This includes occupied dwellings, institutional buildings, but also mechanically integrated structures, telecommunication infrastructure, ecological receptors, and receptor clusters with cumulative vulnerability. Receptor-specific calibration must account for structural type, occupancy status, mechanical load, and environmental sensitivity—particularly in rural and semi-rural zones where redundancy is limited and receptor diversity is high. Without a complete receptor inventory, compatibility studies risk underestimating and overlooking offsite impacts, violating planning instruments such as PPS 2024 Section 1.2.6.1, and failing to uphold the public interest in land use integrity, environmental protection, and infrastructure resilience. The overarching objective remains the protection of public health, safety, and welfare through receptor-specific calibration and perimeter-based monitoring. This receptor inventory must be publicly disclosed and independently verified before any potential planning approval or licence issuance, ensuring transparency, defensibility, and alignment with statutory obligations under the Planning Act, Aggregate Resources Act, and Environmental Assessment Act.

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APPENDIX-A
Vibration Damage Case Studies – Structural Impact, Emotional Distress, and Legal Precedent

This appendix presents documented case studies and technical findings illustrating the real-world consequences of quarry blasting on nearby communities, structures, and individuals. These examples are included to support receptor mapping, setback modelling, and land use compatibility analysis under PPS 2024 and the Caledon Official Plan. The selected cases demonstrate that vibration-related impacts are not limited to ground motion alone. Acoustic overpressure (concussion) generated by blasting can exceed ground vibration in both structural significance and human sensitivity. Research by Taylor (1975) and Siskind et al. (1980) confirms that sonic boom criteria—originally developed for aerospace applications—are applicable to quarry blasts, particularly in rural and semi-rural contexts where legacy construction and slab-mounted infrastructure are prevalent.

Legal precedents such as *Alonso v. Hills et al.* (1950) further establish that cumulative blasting impacts—including flyrock, structural damage, and emotional distress—can give rise to compensable nuisance and injunctive relief. These cases also affirm that inferential and circumstantial evidence of damage may outweigh direct expert testimony, reinforcing the importance of community-based observations and visible injury documentation. Together, these studies and rulings underscore the need for precautionary planning, receptor sensitivity analysis, and mitigation measures tailored to the structural and social realities of rural and semi-rural Ontario. They provide probative support for the inclusion of vibration-sensitive receptors in compatibility studies and reinforce the statutory obligations under PPS 2024 Policy 2.4.4, Policy 2.6, and the Ontario Heritage Act.

According to A. G. Taylor (1975), the acoustic wave (concussion) generated by quarry blasting can be of greater significance than ground vibration induced by the same blast. Both Taylor (1975) and Siskind, et al. (1980) agree that sonic boom research can be applied to quarry blasts:[24]

> *Quarry blasts were monitored during 1973--1974 at several locations in Southern Ontario to determine if the acoustic wave (concussion) was likely to be of significance from the points of view of structural damage and human annoyance. The monitoring instrumentation used included sonic boom microphone-- carrier system and FM tape recorder. The characteristics of the blast wave, overpressure, spectrum, and duration were analyzed using a storage oscilloscope and real-time analyzer and were compared with the characteristics of sonic booms. The two phenomena were shown to be similar in spectral content to most energy in the infrasonic region; the overpressure at several thousand feet from a blast can be similar to that of a sonic boom, whereas the duration of the pressure perturbation is several times longer for a blast than for a sonic boom. It is concluded that damage and annoyance criteria developed from sonic boom research may reasonably be applied to quarry blasts. It was also found that in many instances the acoustic wave can be of greater significance than ground vibration induced by the same blast.*

The following case studies illustrate the range of structural, perceptual, and legal consequences associated with quarry blasting in rural and semi-rural contexts.

Blast Vibration Damage 1

In *Alonso v. Hills et al.*, (1950),[25] as a consequence of recurrent quarry blasting operations, the California appeal court upheld the trial court's damages award of $2,650, consisting of $1,650 for damage to and depreciation of the property, and $1,000 for the plaintiff's distress in body and discomfort, annoyance, fright and shock. According to the homeowner, the residence is located in Rockaway Beach, a community of 300 homes and 200 yards (183 metres) distant from the quarry. The evidence that there were 85 homes and the distance was 300 yards (274 metres) from the quarry had no bearing on the outcome of the case.

Blasting conducted at the quarry on November 2, 1946, February 3, 1947, and on many occasions before and after caused violent concussions in the nature of earthquake thereby injuring plaintiff's real

[24] Taylor, A.G., "Quarry blast acoustic wave (concussion) – response of structures and human annoyance," *Ontario Ministry of the Environment*, Toronto, *JASA*, https://asa.scitation.org/doi/pdf/10.1121/1.1995087.

[25] *Alonso v. Hills*, 95 Cal.App.2d 778 (1950) 214 P.2d 50, https://scholar.google.ca/scholar_case?case=4442811314394772785&q=Alonso+v.+Hills&hl=en&as_sdt=2006.

property and building, and disturbed the enjoyment of the dwelling by plaintiff and his family, shocked plaintiff's nerves and injured his health, and caused his children great fear. The February 3, 1947 quarry blast launched a 3-pound rock (flyrock) that destroyed a bench on the property near which one of the plaintiff's daughters was standing, causing the plaintiff to lose sleep and fear for his security and that of his family.

> *[2] The recurrent blasting in the operation of defendant's quarry, causing cumulative injury to plaintiff's property and interference with its enjoyment and requiring injunctive relief could conceivably be considered as one line of conduct in the character of a nuisance giving rise to one cause of action, without necessity of separate statement of separate blastings.*

On the issue of the relevance of expert evidence argued by the quarry owner, the appeal court ruled that expert testimony was not entitled to preference over testimony as to facts, and that inferential evidence can overcome direct evidence:

> *…[R]egular scientific expert testimony is not entitled to preference over testimony as to facts; the relative weight must be decided by the trier of facts. (Rolland v. Porterfield, 183 Cal. 466,469 [191 P. 913].)*
>
> *[8] The finding that on November 2, 1946 [before the blast], plaintiff's property was of the reasonable value of $5,000 finds competent support in plaintiff's testimony that he figures the valuation of his house at that time in the neighborhood of $5,500. (Isenberg v. Sherman, 212 Cal. 454, 483 [298 P. 1004, 299 P. 528], 10 Cal.Jur. 1023.) Appellant's attack on plaintiff's evidence on the ground of contradictions in his statements as to his cost price go to the weight of this evidence only, of which the trier of facts is the sole judge.*
>
> *[9] It is true that there was no direct evidence as to structural weakening. However, plaintiff testified that after the November 2 blast there were cracks all through the exterior of the house, the stucco outside was buckled, the window sills and frames all knocked out of proportion, the plumbing leaking, barbecue pit and terrace ruined. From such evidence of visible injury an inference can be drawn that also the general structural strength of the building must have suffered. Whether the inference should be drawn in this case was again for the trier of facts. (Blank v. Coffin, 20 Cal. 2d 457, 461 [126 P.2d 868]; 10 Cal.Jur. 738,739.) Such inferential evidence can also overcome direct evidence to the contrary. "[I]t is elementary that direct evidence may be disbelieved and contrary circumstantial evidence relied upon to support a verdict or finding." (Gray v. Southern Pacific Co., 23 Cal. 2d 632,641 [145 P.2d 561].)*

Blast Vibration Damage 2

In *Davis v. L & W Construction Company*, (1970), *air concussions* and ground *vibrations* from blasting at a quarry about six-eighths of a mile (1,207 metres) away damaged the Davis residence. Their two-storey residence, measuring 32' × 32', is a stucco covered and hollow tile structure, with basement, and was in "good solid condition prior to the blasting" by the quarry operator. When quarrying operations were in progress, which had worsened by 1966, the Davis' house shock, a window broke, and structural cracks began to appear. An experienced building contractor testified on behalf of the homeowners, stating that one time while in the home the building was in good condition, and that during a second visit he found cracks, "both diagonal and vertical." He concluded,

> *[V]irtical or horizontal cracks cannot result from settling and are usually caused by jar, shaking or possibly wind.*

Neighbours Albert Poli and John Head also testified as to the damages each sustained to their home as a consequence of the blasting quarry operations.

> *Albert Poli stated he lives about three-fourths mile [1,207 metres] west of the quarry, in a 24' × 48' frame house with cement block basement. The structure had never settled, but the foundation is shaken and cracking all over.*
>
> *John Head testified he resides approximately 70 rods [352 metres] southeast of plaintiffs [Davises], or about one and a fourth miles [2,012 metres] from the quarry. He had seen cracking and hairline cracks in the Davis home. His more remote residence trembled whenever there was blasting at defendant's quarry, and every room reveals damage to plaster and paper.*

The Iowa Supreme Court ruled in favour of the Davises and awarded damages, measured as the loss in market value, based on a before-and-after-blasting analysis, while holding the quarry operator "liable without fault" for engaging in a notoriously hazardous activity.

> *Surely it is a matter of common knowledge, and we accord judicial notice to the fact, that blasting by use of dynamite or other explosives is a hazardous activity and as such likely to damage others. See Boyce v. United States, D.C., 93 F.Supp. 866, 868; 31 C.J.S. Evidence § 9, page* ★226 *824; and 29 Am.Jur.2d, Evidence, section 23, page 60.*
> *Since 1916 we have consistently adhered to that concept sometimes previously referred to as strict liability, but in cases of the nature here involved, now more appropriately termed "liability without fault". See Lubin v. City of Iowa City, 257 Iowa 383, 131 N.W.2d 765; Monroe v. Razor Construction Co., 252 Iowa 1249, 110 N.W.2d 250; Pumphrey v. J. A. Jones Construction Co., 250 Iowa 559, 94 N.W.2d 737; and Watson v. Mississippi River Power Co., 174 Iowa 23, 156 N.W. 188. Also Annos. 20 A.L.R.2d 1372, 1375.*
> *…[I]f one engages in an activity on his own land of such hazardous nature as to involve risk of harm to the person, land or chattels of neighboring parties, he is liable for the consequences proximately resulting therefrom without regard to degree of care, scientific manner in which done, purpose or motive. Watson v. Mississippi River Power Co., supra, at 174 Iowa 29-31, 156 N.W. 188; Davis v. Georgia-Pacific Corporation, Or., 445 P.2d 481; Harper and James on the Law of Torts, section 14.6, page 815; and Restatement, Torts, section 520.*
> *And, as stated in Monroe v. Razor Construction Co., supra, loc. cit., 252 Iowa 1252, 110 N.W.2d 252: "Under this rule, negligence of the defendant need not be shown as an essential element of plaintiffs' recovery." See also Cronk v. Iowa Power & Light Co., 258 Iowa 603, 613, 138 N.W.2d 843.*
> *Consequently the user of explosives acts at his own peril and is liable if damage proximately results to another, either from the direct impact of debris thrown by the blasting, or from consequential concussions or vibrations. In addition to authorities cited, supra, see Exner v. Sherman Power Const. Co., (2 Cir.) 54 F.2d 510, 512-513; Garden of the Gods Village v. Hellman, 133 Colo. 286, 294 P.2d 597, 600-601; Morse v. Hendry Corporation, Fla.App., 200 So.2d 816, 817; Berg v. Reaction Motors Div., 37 N.J. 396, 181 A.2d 487, 492-494; Davis v. Georgia-Pacific Corporation, supra, loc. cit., 445 P.2d 483; Bedell v. Goulter, 199 Or. 344, 261 P.2d 842, 845-846; and Annos. 20 A.L.R.2d 1372, 1377.*

Blast Vibration Damage 3

From January 2007 through January 30, 2009, 104 complaints were filed against White Rock Mining in connection with noise and property damage from ground vibration caused by blasting quarry operations in South Florida, for which the quarry owner denied responsibility.[26]

> *In every case, the fire marshal visited the homes, took pictures of the damages, and interviewed the homeowners. Some described the noise as "very loud and frightening," and others said the house shook like an earthquake, with vibrations causing pictures to fall off the wall and dishes in the cabinets shaking.*
> *The fire marshal inspector then verified the blasting schedules at the different blasting sites and found they had not exceeded the requirements established by Florida law.*
> *In every case the result was "no violation…."*
> *That White Rock is responsible for the blasting damage is further emphasized by the fact that when the blasting stopped, so did the claims for property damage.*

A May 13, 2021, news release and broadcast by 7 News Miami[27] describes and shows the damage sustained by properties of homeowners in proximity to the White Rock quarry, with the quarry operator, as expected, denying being responsible for the damages caused by vibrations from repeated blasting.

> *White Rock Quarries is the closest to many of the homes and businesses feeling the vibrations.*
> *The company tells us "the data from multiple independent studies … is very clear: blasting within existing limits (which are among the strictest in the nation) does not damage homes."*
> *And…*

[26] Quarry blasting will cause severe damage - Shelby County Reporter | Shelby County Reporter, February 10, 2010.
[27] Ozebek, Kevin. "Shaking Mad: South Florida residents believe blasting from nearby quarries causes damage to their properties, *7 News Miami*, May 13, 2021. https://wsvn.com/news/special-reports/shaking-mad-south-florida-residents-believe-blasting-from-nearby-quarries-causes-damage-to-their-homes/.

"Our blast vibrations are not stronger, but due to increasing residential encroachment and people spending more time at home due to COVID-19, the perception of our blasting may be heightened more than previous years."
But, these businesses and homeowners are convinced it is the blasting behind these cracks….
At first, they feel a rumble. Then, they worry if their homes are damaged. Many residents in part of South Florida are shaking mad from blasting at nearby quarries….
Jeffrey Batic, homeowner: "Sometimes it can even knock you off your feet if you're not careful. It is strong, and it has only gotten stronger."…
Jeffrey Batic: "This crack towards the foundation continues all around the entire home."
And they are not the only ones having this feeling.
Idel Llavore: "Please somebody help."
Idel Llavore says she has spent tens of thousands of dollars fixing cracks on her home and property.
Last year, she fixed these deep cracks around her pool.
In some of her new tiles, she's already finding new cracks.
Idel Llavore, homeowner: "I am driving my husband crazy because I have a panic attack. Every time I feel a blast, I start screaming."
Miguel Martinez is also seeing cracks on the concrete floors of his occupational therapy clinic.
Miguel Martinez, business owner: "One day when a blast hits and dead silence breaks in the room, we watch this crack start emanating right after the blast goes through."
Homeowners in some neighborhoods in Northwest Miami-Dade and Miami Lakes have put up with the blasting at nearby quarries for years, but Miami Lakes Mayor Manny Cid says the complaints are escalating.
Miami Lakes Mayor Manny Cid: "It has progressively gotten worse. The intensity has definitely gone up."…

Blast Vibration Damage 4

On June 25, 2007, the Town of Niagara, New York, served LaFarge with an injunction ordering it to "cease and desist operations" detrimental to residents of the nearby Tuscarora Village mobile home community.[28]

> *The order claims the quarry has violated town law by creating dust and other safety hazards harmful to nearby residents. In addition, the noise and vibrations from the blasting have hurt residents' quality of life and damaged portions of their homes, the order said.*

According to Tuscarora Village residents, vibrations from the blastings have damaged a large percentage of their homes, including some that are severely damaged. For the past several months, Ruth and her neighbors have complained effects from the blasts have damaged their manufactured homes and presented health hazards. After a series of discussions and environmental testing, the quarry was ordered by the town in June [2007] to cease and desist the rock blastings. Tuscarora Village is located within 100 yards of the quarry's east end. The company has plans to blast on that side through October [2007] before moving to the other side. Residents don't think their homes can sustain blastings for that long. They've hired the law firm of Magavern, Magavern and Grimm to represent them in the ongoing dispute against not only LaFarge, but also the owners of Tuscarora Village for allegedly not being upfront about the potential hazards. Attorney Richard Grimm said the firm represents a number of the village's residents and is still investigating whether a lawsuit is appropriate.[29]

> *A resident of Tuscarora Village suffered a concussion and a lower back sprain Friday after falling in the shower while the quarry was blasting. She was treated at Mount St. Mary's Hospital and is now recovering at home.*

Effects from the latest blasting at LaFarge quarry has led to the injury of a 51-year-old Tuscarora Village resident, according to a police report Friday. Town of Niagara police responded to 4253 Mohawk Place for a woman who fell and struck her head while she was in the shower, Police Chief James Suitor said. The victim told police she fell while her home was shaking from the nearby blast at the quarry.

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[28] Forgione, Rick. "Town of Niagara: Town halts quarry blasts," *Niagara Gazette*, Jun 25, 2007, https://www.niagara-gazette.com/news/local_news/town-of-niagara-town-halts-quarry-blasts/article_c2fa654c-44f7-5e67-86a6-674269df72e4.html.

[29] Forgione, Rick. "TOWN OF NIAGARA: LaFarge meets with neighbors," *Niagara Gazette*, July 25, 2007, TOWN OF NIAGARA: LaFarge meets with neighbors | Local News | niagara-gazette.com.

Effects from the latest blasting at LaFarge quarry has led to the injury of a 51-year-old Tuscarora Village resident, according to a police report Friday. Effects from the latest blasting at LaFarge quarry has led to the injury of a 51-year-old Tuscarora Village resident, according to a police report Friday.[30]

> *[Town Supervisor] Richards was on site during that blast and immediately contacted Town Attorney Michael Risman to research possible action against LaFarge to halt future blastings….*
>
> *Tuscarora Village residents realized something was different at the quarry almost immediately Monday when everything was silent as they walked outside, said Sharon Ruth, who is among the residents who have opposed the blastings.*

A recent promise from the LaFarge quarry that the severity of on-site rock blasting would be reduced and no longer cause damage to mobile homes in Tuscarora Village had resident Sharon Ruth feeling hopeful. Until her fish tank exploded on Monday [June 18, 2007]. "That was the biggest rumple I've experienced in two years," Ruth said about the most recent blast at the quarry, which sits about 300 feet away from Tuscarora Village in the town of Niagara. The end result was an exploding fish tank that broke into pieces on top of her cat, adding to the estimated $67,000 in damages she says her home has sustained in the past two years due to the blastings.[31]

> *"We're glad that steps are being taken, but they're only temporary steps," she said, adding that residents still ask for what they've wanted all along. "We don't want to get hurt, we don't want to get sick and we don't want our houses caving in."*
>
> *Bill Poole, general manager of the quarry, could not be reached for comment Monday afternoon [June 25, 2007]. He said Friday the quarry has taken steps to reduce the level of blasting, despite being within legal limits according to federal regulations.*

In September 2007, sixteen (16) residents of Tuscarora Village sued LaFarge for damage to their homes caused by vibrations from blasting at the Quarry and the companies that own Tuscarora Village for failing to reveal that blasting would occur nearby. A prior June 22, 2007, article[32] written by the same journalist, reported an injury suffered by a resident in Tuscarora Village from a blast at the nearby LaFarge Quarry.

> *Residents of Tuscarora Village, which sits about 100 yards from the quarry, have been complaining for months the effects from the blastings rock the mobile home park and have caused thousands of dollars in damages.*
>
> *Friday's incident was the first reported human injury the blasting has been accused of causing.*
>
> *"I kept saying 'is it going to take someone getting hurt?' before something is done about this,' said Tuscarora Village resident Sharon Ruth. "What happened out here was shocking."*
>
> *After residents took their concerns to the town board last month, a meeting was set up with LaFarge officials, who agreed to lower the blasting levels despite the company being within the federal regulations. However, in the three jobs [blasts] since, both residents and town officials believe that hasn't happened.*
>
> *"It felt like someone dropped a bomb over here today," Ruth said Friday. We had more damage today than we've ever had."*
>
> *LaFarge General Manager Bill Poole told the Niagara Gazette Friday afternoon he had not heard about the injured resident. "That's horrible, I'm sorry to hear that," Poole said.*
>
> *Poole contests the quarry has made "substantial" changes to reduce the effects from the blast. According to their readings, the blasts have gone down in velocity in each of the last three jobs [blasts], and are functioning at one-twentieth of what is allowed.*
>
> *"We have made a commitment to try and reduce the shocks, even though we were operating within our permit limits," Poole said, adding the reductions are costing the quarry money.*
>
> *Federal guidelines set the maximum level at 2.0. Poole said the blast on June 3 [, 2007] carried a .265 velocity—13 percent of what is allowable. The June 13 [, 2007] blasting was reduced further, he said.*

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30 Forgione, Rick. "TOWN OF NIAGARA: Quarry blast injures woman," *Niagara Gazette*, Jun 22, 2007, TOWN OF NIAGARA: Quarry blast injures woman | Local News | niagara-gazette.com.

31 Illinois Department of Transportation and Vulcan Materials Company Reach Settlement on Joliet Road Closure, *IDOT*, May 17, 2010.

32 Forgione, Rick. "TOWN OF NIAGARA: Quarry blast injures woman," *Niagara Gazette*, Jun 22, 2007, TOWN OF NIAGARA: Quarry blast injures woman | Local News | niagara-gazette.com.

"We understand the residents' frustration, but to be honest, we're equally frustrated because we have made changes and they still think it's an unacceptable level," Poole said. "It makes you question why a trailer park was put in that spot in the first place."
The shaking wasn't the only thing residents were complaining about Friday. Ruth said a huge cloud of yellow dust engulfed the mobile home park following the noon blasting. "It looked like little Bosnia out here again," she said.
A representative from the state Department of Environmental Conservation was at the park recording readings of the air during the work. Town Supervisor Steven Richards, who also was present at the time, said the impact felt no different than previous times. "That's totally unacceptable to me," he said, adding the cloud of dust and smoke was his primary concern. "That can't be healthy to the residents over there."
Richards said he is working with local, state and federal health and environmental officials in an attempt to secure a court order forcing LaFarge to stop blasting until the effects of the dust clouds can be tested….

Blast Vibration Damage 5

On November 5, 2013, a blast at a McCook quarry sent tremors that shook the western suburbs of the Village of La Grange, Illinois, which the quarry operator dismissed as a "routine blasting operation." Blasting at the quarry has been a rocky road for thousands of residents for more than a decade in dealing with the fallout from quarry blasting.

According to the Village of La Grange, the company denies its blast was out of the ordinary and behind the tremor that shook the western suburbs just after 12:35 p.m.
"Hanson Material Service quarry has stated that they were performing routine blasting operations at 12:35 p.m. today and that the blast was consistent with their typical operations. The quarry reports that the recorded seismic readings related to the blast were below regulatory limits," according to a message posted on the village website.
"Further, the quarry states that approximately seven seconds after the blast, a separate seismic event was recorded. Hanson is in the process of reviewing the seismic readings in order to better understand what may have occurred, but at this time they are denying any correlation between their blast and the seismic event."
The U.S. Geological Survey (USGS) says the magnitude of Monday afternoon's blast in the western suburbs registered at 3.2, down from an initial estimate of 3.7 earlier in the day.
Patch readers have shared comments about the blast, which caused "pictures to jump off walls," and entire houses to shake, according to commenters.
Here's what people had to say on the La Grange Patch Facebook page:

- *Dawn said she felt it downtown, near the train station. "We thought a truck hit the building in the alley, because that is a common occurrence."*
- *Liliana said, "My mom heard it and felt it at 50th and Ashland. She says she wouldn't be surprised if there are cracks in the walls of her house. Direct quote: 'It felt like the house shook right off of its foundation."*
- *Monique said, "We're real close to the quarry and felt a normal blast followed by the house levitating about 5 seconds later."*
- *Jamie said, "(It) Totally shook my house. Heard the blast. Felt the shake."*
- *Sean said, "Felt and heard it on Stone. Shook all the glassware in the cabinets."*
- *Karen said, "No way[,] it was the quarry... Oak Brook, Downers Grove, Hinsdale all reporting it too."*
- *Catrina said, "Not understanding how they can deny that the blast wasn't out of the ordinary!?! The apparently "ordinary blast" was heard before the tremor that shook our home and literary made me jump just from the sound. Now I'm not used to earthquakes, but do they normally make an explosion noise first?"*
- *Claudia said, "The entire 300 block Leitch ave shook."*
- *Karen said, "Foundation shook, felt like a truck hit the house, LaGrange Country Club area!"*
- *Tom said, "Felt on Hillgrove"*

- *Christine said, "We felt it in La Grange, whole house shook for several seconds. 0-100 blk N Spring"*
- *Bill said, "Felt strong in LGP (wife) and Wheaton (me) for a sec."*
- *Becky said, "All the neighbors in 100 block S Catherine."*
- *Melissa Felt it in Brookfield."*

For thousands of residents in and around southwest suburban McCook, it has been a rocky road for more than a decade in dealing with the fallout from quarry blasting.[33] Although some quarry operations have been there for a century-- using explosives to dislodge limestone-- the testy battle between community groups, companies and public officials is more recent and ongoing…. The I-Team obtained photos from one Countryside resident who says Monday's blast cracked walls and she thought her house was going to collapse. She and other residents who live around here say the concussion on Monday was the worst in years, although the ground shakes on a regular, sometimes daily, basis.

There was such damage to Joliet Road along the Vulcan Quarry in McCook that in 1998 state officials closed the roadway after determining it was unsafe for public use.

> …[In 1010, after a 12-year legal battle] --- without admitting any wrongdoing — Vulcan paid a $40 million settlement to the Illinois Department of Transportation [IDOT]. A repair project is now in its infancy-- with Joliet Road remaining closed-- and affecting motorists and rail traffic every day.

The one-mile stretch of Joliet Road…was closed in May 1998 because the road was substantially damaged and unsafe for vehicular traffic. The one-mile stretch runs through the middle of two Vulcan open pit quarry mines, one to the north and one to the south. IDOT experts concluded that the roadway was destabilized from years of mining by Vulcan Materials Company and any attempts to repair and reopen Joliet road would require frequent and expensive maintenance, including lane closures. Vulcan Materials at the time would not agree to the state-requested mining setbacks and land contribution that would have been necessary to implement any of the repair options suggested since the section of Joliet Road was closed. Since the closure, thousands of vehicles that used the road each day have been re-routed to arterial roadways.[34]

Blast Vibration Damage 6

On April 25, 2017, a blast at the 54-acre Jefferson Quarry in Mankato, Minnesota, struck with such force that it was initially thought to be an earthquake. The quarry owner refused to accept financial responsibility for the widespread damage caused to the homes of 128 nearby residents,[35] despite evidence of flyrock debris. The quarry blast was amplified by atmospheric conditions to create the equivalent of a magnitude 2.8 earthquake, and was heard miles away.[36]

> *A blast at a locally owned quarry here two months ago struck with surprising power. An earsplitting boom was followed by a violent trembling that shook homes and garages to their foundations, toppled lamps off tables and knocked one man over as he tended his backyard garden.*
>
> *In the investigations that followed, a government scientist said the ground shook because of an explosion at the Jefferson Quarry. But the mining company said its own research found that an earthquake had struck the city seven seconds after it set off charges.*
>
> *The resulting standoff has left homeowners wondering who will pay for all the cracked plaster and other damage, and whether it will be months or even years before legal action can resolve who's at fault.*
>
> *"Nobody wants to take responsibility for anything," said Ann Helgeson, who bought her house adjacent to the quarry just weeks before the ground shook. She was home with her young son that day when the house started to shake from the cellar up.*
>
> *Now, the freshly painted walls are cracked and portions of the once-flat floor dip. Gaps can be seen where the living-room ceiling meets the wall. "We've got cracks upstairs everywhere," said her 6-year-old son, Gage.*

[33] "Recent quarry blast not the first to shake McCook," *abc30*, November 5, 2013, https://abc30.com/archive/9315049/.
[34] Illinois Department of Transportation and Vulcan Materials Company Reach Settlement on Joliet Road Closure, *IDOT*, May 17, 2010.
[35] McKinney, Matt., "Was Mankato boom a mine blast or an earthquake?", *Star Tribune*, July 2, 2017.
[36] https://www.duluthnewstribune.com/news/4256859-mankato-quarry-blast-rocks-city-feels-earthquake.

> *Helgeson's insurance company inspected the damage in early May and left her thinking that it would be covered. It wasn't until a letter arrived in the mail last week that she learned the company had determined the cracks were caused by natural settling and therefore were not insured….*
> *Left without other options, Helgeson said she's hoping someone from the city will step in to help her and some of the other 128 homeowners who reported damage.*
> *"I myself have been saying the city should start a class-action lawsuit against [quarry owner Jordan Sands]. We need somebody impartial to come in," she said.*

Following the April 25, 2017, quarry blast, the city suspended the quarry's permit, and again in August 2017 after several neighbours reported an August 8, 2017 quarry blast that launched flyrock debris and damaged neighbouring properties. In September 2017, the Mankato Department of Public Health informed the quarry owner that its permit would not be reactivated. An investigation had shown "that there is public safety danger with the use of explosives at the quarry."[37]

Blast Vibration Damage 7

On May 13, 2015, a quarry blast, which prompted the city of Augusta, Maine, to file a lawsuit, caused damage to the homes of neighbouring residents.[38] As expected, the quarry operator denied responsibility for the damage.

> *Some residents near a quarry operation in a pit off West River Road that has been controversial with its neighbors say a May blast that prompted the city to file a lawsuit also caused cracks in the floors of their homes.*
> *A resident who lives about two-tenths of a mile [322 metres] north of the pit's entrance on West River Road and roughly 2,000 feet [610 metres] away from the pit itself says she believes the concrete floors and walls of the basement in her 8-year-old home were cracked by the May 13 blast, which she said felt and sounded like a bigger blast than other blasts at the pit owned by Steve McGee Construction.*
> *Donna Bonenfant said gaps of roughly a quarter-inch opened up between several of the floor joists and the main support beam of the main floor of her home, visible from the basement, gaps which she said weren't there before the blast. What appear to be water stains are visible around some of the cracks in her basement walls.*
> *"I don't know what to do about these. What if it leaks?" Bonenfant said, pointing to one of several cracks spread across parts of the concrete basement floor of her home. "I know to expect some cracks, but this many? A cement contractor looked at it and said there is no way all these cracks would come from just the house settling."*
> *Across the Kennebec River from the pit site, Riverside Drive resident John Liacos said he noticed hairline cracks in some of the ceramic floor tiles installed when his home's kitchen was redone in the spring of 2014, which he doesn't believe were there before the May [13, 2015] blast. He said he's also discovered small cracks in the drywall of the kitchen ceiling.*
> *Liacos acknowledged he's not sure of the date when he first noticed the cracks, but said a contractor who looked at the cracks said they had to have been caused by "something serious," and Liacos suspects it was the blast.*
> *Bonenfant and Liacos both said they contacted the company that did the blasting, Maine Drilling and Blasting, to file claims for the damage. Both said their claims were rejected.*
> *"We got a letter saying, sorry, we're not responsible for it," Liacos said. "If nobody is willing to admit it, what are you going to do? I want to be treated fairly. I was hoping to get some sort of resolution from Maine Drilling and Blasting."*

Cheri and Pietro Nicolosi, who live on Kenneth Street in the Grandview neighborhood about 1,000 feet (305 metres) from the West River Road quarry operation filed a lawsuit on July 7, 2017, against the city of Augusta, McGee Construction, and Maine Drilling and Blasting seeking compensation for

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[37] Goodrich, Kristine., "County attorney declines to file charges in quarry blast," *The Free Press*, Oct 11, 2017. https://www.mankatofreepress.com/news/local_news/county-attorney-declines-to-file-charges-in-quarry-blast/article_ed0f241e-aece-11e7-b449-0bee8d49d9c0.html.

[38] Edwards, Keith., "Augusta quarry pit neighbors say blasting damaged Homes," *Kennebec Journal*, September 21, 2015, https://www.pressherald.com/2015/09/21/augusta-quarry-pit-neighbors-say-blasting-damaged-homes/.

damages to their home and to have McGee's permit to blast and extract rock at the quarry site revoked.[39] The lawsuit claims blasting close to the Grandview neighborhood constitutes an "'ultrahazardous activity,' poses a high degree of harm and is an abnormally dangerous activity."

> *…[The lawsuit] alleges that since 2011, the couple's home, in the Grandview neighborhood about 1,000 feet [305 metres] away from McGee's quarry, sustained "cracks in the basement, damage to exterior walkway and drivel, floor tile cracks, nails popping, wall cracking, issues with water quality, uneven living room bay window, grout in bathroom floor deteriorated, shower lead [sic] issues, black mold in dishwasher and shower, and problems with a dining room light and the septic system.*

An August 22, 2017 report prepared by Golder Associates,[40] in response to numerous complaints to the City of Augusta, Maine, over the past 15 years concerning blasting at the McGee quarry. Golder did not bother to review the submitted complaints", but understands the file includes numerous complaints related to emotional distress and concerns about structural impacts to (22 homes)" located roughly 750 to 1,700 feet (229 to 518 metres) north off the quarry. In this respect, the Golder report made the following admissions:

> 10. It is possible that poor foundation support conditions for a home may present conditions more susceptible to structural damage from blasting vibrations than typically cited in the literature….
>
> 11. It is possible that geological conditions and/or site-specific structure response from blasting vibrations could present conditions more susceptible to structural damage than typically cited in the literature….
>
> 13. All of the blast vibrations reviewed would be considered "strongly perceptible" to "disturbing" based on human perceptions of blasting… This conclusion is consistent with information presented by MD&B in their 11/10/16 presentation. Human beings can detect vibrations as low as about 0.02 in/s [0.508 mm/sec].
>
> 14. Human perception and quality of life criteria are a significant and increasing factor in the development of allowable vibration and airblast overpressure standards for blasting ordinances for quarries and construction. Criteria based on structural damage probability versus that for quality of life are a common controversial issue pitting annoyance and emotional effects of nearby residents against the financial interests of quarry operators and construction companies.
>
> 15. Review of allowable vibration criteria for other selected towns/cities in Maine, Maine DEP guidelines for quarries…, and European guidelines indicate Augusta's current criteria are similar to somewhat more restrictive than most, but there are exceptions. Of those reviewed, the City of Westbrook appeared to have the most restrictive vibration criteria for quarry blasting in Maine (0.5 in/s [12.7 mm/sec] maximum PPV for all cases except for a specific residence where 0.25 in/s [6.35 mm/sec] applied). Review of selected international standards indicates Germany has one of the more restrictive European guidelines with residential vibration limits between 0.2 and 0.8 in/s [5.08 mm/sec and 20.32 mm/sec] depending on frequency – these criteria appear to be intended to eliminate the possibility of even minor structural damage and substantially limit human complaints.

Blast Vibration Damage 8

In *School District No. 162 et al. v. Grosshans & Petersen, Inc.* (1959),[41] the trial court found the quarry operator responsible for damages to the plaintiffs' properties caused by ground vibrations stemming from quarry blasting, a ruling upheld by the Supreme Court of Nebraska. The blasting activities that led to the vibration damage are described as follows:

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[39] Edwards, Keith. "Lawsuit over blasting filed against city of Augusta, local construction, blasting firms," *Kennebec Journal*, updated July 27, 2017. https://www.centralmaine.com/2017/07/26/lawsuit-over-blasting-filed-against-city-of-augusta-local-construction-blasting-firms/.

[40] "Preliminary Findings, Review of Selected Blasting Records and Project Information, McGee Quarry, City of Augusta, Maine," Golder Associates, August 22, 2017. https://cms6.revize.com/revize/augustame/GolderReport_170822%20Augusta%20Prelim%20Findings.pdf

[41] *School District No. 162 v. Grosshans & Petersen, Inc.*, 99 NW 2d 601, 169 Neb 357 – Neb: Supreme Court 1959. https://scholar.google.ca/scholar_case?case=16359838068859829093&q=school+district+no+162+v+grosshans+%26+petersen+inc&hl=en&as_sdt=2006.

> *Beginning about December 23, 1955, and at various times until April 27, 1956, defendant used dynamite to blast rock in the quarry. The blasting was so done as to break the rock into pieces sufficiently small to go through a crusher so that the rock could be used in highway construction. Defendant often prepared as many as 48 holes for one explosion. These were drilled to depths of as much as 20 feet (6.1 metres). Dynamite was placed in these holes to within 30 to 36 inches (0.762 to 0.914 metres) of the top. Dirt was then tamped in the holes to lessen any upward push of the explosion. The dynamite was so wired that it exploded in "delays" of 25/1000 of a second, and there were from two to four delays in each explosion. Beginning December 23, 1955, and ending April 27, 1956, defendant exploded dynamite 2 days in December, 9 days in January, 10 days in February, 21 days in March, and 11 days in April. On several days there were two and sometimes three and four explosions a day.*

The age and condition of the schoolhouse before the quarry blasting operations, and the damage to the schoolhouse from the ground vibrations, are described as follows:

> *The school building was built about 1920. It was of brick construction on a concrete foundation. There was no steel reinforcement. Sometime before 1954, a settlement crack appeared in the east wall. That was repaired in 1954. There is also evidence of some replastering that was done before that time. The building was inspected, repaired, and repainted in 1954.*
>
> *During the months of the blasting, large cracks appeared in the walls of the schoolhouse where the brick separated, and cracks appeared in the plaster on the walls and ceiling, and in the concrete tunnel in the basement. Bricks pulled away from joists at the top of the walls. The extent of these cracks need not be recited as the extent of the damage to the building is not an issue here. It is sufficient to point out that they appeared to a large extent in that part of the building that received the first impact of vibrations from the quarry.*

The quarry is located about one-half mile (805 metres) from the schoolhouse and lay witnesses within a 2½ mile (4.02 kilometre) radius of the schoolhouse, and other witnesses closer to the schoolhouse testified as to the damage caused by ground vibrations emanating from blasting operations at the quarry.

> *Plaintiffs offered evidence of lay witnesses living within a radius of 2½ miles (4.02 kilometres) of the schoolhouse, and other witnesses who were close to or in the schoolhouse when blasts occurred. These witnesses described the effects of explosion blasts at the quarry which they observed as "the house shook"; "vibration" was felt when a car was driven near the quarry; "barn vibrated"; the "house commenced to quiver and the windows rattled"; "dishes rattled in the cupboard"; an elevator building "shook," windows rattled, and "the bars on my scale * * * rattled"; "could feel the ground shake"; cans on the shelves of a store "shook" and the floor "shook"; china in a cabinet "shook"; large rocks (flyrock debris) were blown out and upon land of one of the witnesses; the blast "shook the earth"; a furnace rattled; in the school building the blast "shook us"; light fixtures swayed; and there was rattling of the windows and vibration in the schoolhouse.*
>
> *The above paragraph is not an all-inclusive statement of the evidence of what lay witness after witness testified as to what they saw and observed.*

The testimony of the quarry operator's expert witness that "there is no direct evidence that explosions at the quarry caused the damage to the school building" was rejected in favour of the plaintiffs' expert, whose credentials and testimony were accepted by the trial court:

> *Plaintiffs' expert witness was examined and cross-examined extensively and often as to his qualifications. He was a graduate of the College of Engineering of the University of Nebraska; he worked for several years as a structural engineer designing power plant buildings; he worked with a consulting engineering firm doing structural design and cost estimates on schools, churches, dwelling houses, warehouses, and factory buildings; his work involved the structural soundness of masonry walls; in training and practice he had made a study of the various causes of structural failures in buildings in order to avoid their recurrence in buildings designed; he had had formal training in the effect of vibration on structures and in dealing with the loads which come or fall on structures caused by vibration; he had studied writings devoted solely to the subject of ground vibrations; in his practical experience he had noted the effect of forces upon buildings; he had read technical articles and books upon building failures; he had knowledge of the nature of the ground between the quarry and the schoolhouse; he had examined the exposed soil profile at the quarry and made a soil boring at the schoolhouse; and*

he explained the types of vibrations which occur in the soil when an explosion occurs. He testified that in his opinion the damage was caused by a horizontal movement of the bearing walls; as to the effect of a repetition of vibrations, which singly might not cause a failure but if repeated eventually could do so; and that the appearance of the damage may be delayed.

The witness was permitted to testify as to the age, in his opinion, of the cracks in various parts of the building. His testimony in this regard was largely corroborative of the custodian's evidence. He gave as his reason the difference of color of the surface in contrast with the surface of the cracked area, the absence of dust or debris, etc. The witness was also permitted to testify that in his opinion the damage to plaintiffs' building (other than the settlement cracks which appeared earlier and which no one claims were caused by defendant) was caused by a horizontal force which was vibration in the ground.

On cross-examination the witness testified that wind was not the cause of the failure and that the only other possible source of failure was a ground movement exerting force upon the building. He distinguished a settlement crack from the cracks here involved. He testified that the ground vibrations were the only possible cause of the cracks and other conditions that appeared in the building during and after the blasting operations of the defendant.

In fixing the quantum of damages, items requiring repair which existed prior to the quarry operator's blasting operations were excluded from the trial court's award.

Plaintiffs' expert witness on damages excluded any items requiring repair which existed prior to the defendant's blasting operations. He fixed the fair and reasonable cost for the repairs, including architect's fee, at $53,900. Defendant's expert witness made like exclusions and fixed the reasonable cost of repairs at $23,100. Defendant here states that there is no evidence that repairs to preexisting damage were required in order to effect repairs to the damage claimed to have resulted from the blasting. The jury fixed the damages at $25,750.

Blast Vibration Damage 9

Residents in an upscale suburb of Masvingo, Zimbabwe, have had their homes damaged by blasting at the nearby Chifen Quarry, which became operational in 2019.[42]

Scores of houses in Zimre Park, an upmarket suburb in Masvingo have allegedly been damaged by quarry blasts taking place on the outskirts of the city, a charged meeting of residents heard yesterday.

Zimre Park Residents Association is now demanding compensation from Chifen Engineering and Hardware for houses whose window panes were shattered, buildings walls and pillars that developed cracks and ceilings that collapsed as a result of the mining process.

The residents also want Chifen to immediately stop blasting at the mine until its operations are rectified and considered safe.

The worst blast took place on August 29, 2020 and lawyers representing residents and Chifen have exchanged letters on the issue.

One of the residents who declined to be named said that his child survived death when a ceiling that fell during the blast missed his head by a whisker.

The meeting of stakeholders held at Chifen Quarry mining site along Harare Masvingo Highway yesterday [March 9, 2021] sought to resolve the issue. Residents complained that in addition to the damages, their houses shook heavily each time there is a blast at the quarry which is 3km from the suburb.

The meeting also attended by The Mirror brought together representatives of the association including the chairperson Farai Makunike, officials from the Ministry of Mines, a representative of Ward councillor Against Chiteme, Masvingo City Council officials and officials from the Environmental Management Authority.

Chifen was represented by the mine manager Ephraim Mutemachani, What irked residents is that Chifen management allegedly accepts responsibility for the damages during face to face meetings but refuses the same once the matter is reduced to writing.

Mandigora, Mike., "Quarry mine blasts damage Masvingo houses," *The Mirror*, March 10, 2021, https://masvingomirror.com/quarry-mine-blasts-damage-masvingo-houses/.

Chifen lawyers Mutendi, Mudisi and Shumba Legal Practitioners refused responsibility for the damages in a letter written to residents.
However, residents said the same company had already repaired councillor Against Chiteme's house in the same area that was damaged by the blasts.
The letter from the lawyers said that the damage to the houses could have been caused by vibrations from vehicles using Harare Masvingo Highway, swelling and shrinkage of building material or chemical changes in mortar, bricks and plaster.
Chifen however, said that they were bringing in blasting experts to look into the matter and ensure that their work will be safe….
"We are also doing an assessment on the damages and will only act when the results are out," said Mutemachani.

Blast Vibration Damage 10

Despite overwhelming evidence of extensive property damage from ground vibrations (clearly visible in the CBS 42 video) and presented in a follow-up April 30, 2021 CBS article, to homes in Alabama from within a half-mile (805 metres), the nearby quarry owner, Vulcan, denies responsibility for the damage.

If you've ever experienced an earthquake, it's probably something you'll never forget. For neighbors in Tarrant who live within a half-mile of Vulcan Materials, that's how they described what it feels like when the company blasts every week.
…The company uses explosives at its quarry to make gravel, sending off shots about once or twice a week, sometimes more.
"If you're in the homes it feels like dynamite has went off at your house," Tarrant resident Emma Walters said.
The foundation of Walters' home is crumbling. She told CBS 42 she fears that it will cave in one day. Cracks along the front of her house send water flooding into her basement when it rains, and the inside is marked with splits along the walls.
"I know they have a right to make a living, but they don't have a right to destroy my home. My home is all I've got," she said. "My husband and I worked for years for that…"
Despite falling within the proper legal limits, resident(s) are now giving their complaints to city officials. During the Tarrant City Council meeting last week, several residents shared stories of startling sounds, trembling homes and damages they believe were all the result of blasting.
"You all come to our neighborhoods, and you tear up and you tear up and you tear up, under the auspices of the guise of the government," said Tarrant Mayor Pro Tem Tracie Threadford. She explained blasting is even impacting her own home.
Randy Jones, area operations manager at Vulcan Materials, was at the meeting, where he told neighbors while the blasts may cause loud sounds and homes to rattle, the vibrations are monitored and are not strong enough to cause damage.
Residents did not react well to that statement. Many were visibly upset, and soon after shared their stories. One woman even handed out photos showing her ceiling caved in, claiming it was from a blast. She said she now wants to sue….
Since that public hearing, Fleming reported several residents called with complaints, and Vulcan Materials had seismographs installed near their homes to monitor vibrations for future blasts. He added that has been their protocol all along, but there was an influx in phone calls since the hearing. Several seismographs are already installed throughout nearby neighborhoods and monitored for every blast….[43]
We first told you about neighbors concerned about blasting damage in Tarrant last week.
Since then, CBS 42 has heard from more residents claiming the blasts from Vulcan Materials are causing their foundations to crumble and causing cracks all throughout their homes.
Cynthia Hurd Threatt says the blasts caused her ceiling to cave-in twice.
"I heard this thud by the time I got to my bedroom and I came back and looked and my whole living room ceiling was raining sheetrock," she told CBS 42.

[43] Vincente, Chloe. "Can Blasting in Tarrant damage your home? Residents say yes, company says no," *CBS42*, April 30, 2021," https://www.cbs42.com/your-voice-your-station/can-blasting-in-tarrant-damage-your-home-residents-say-yes-company-says-no/.

> *The Alabama State Fire Marshall, who regulates blasting in the state, says he is aware of the growing concerns for residents living near Vulcan Materials. He says he spoke with the Tarrant Fire Department and as of now, they will handle the reports about damages locally.*
> *An official with Vulcan Materials says, since a City of Tarrant public hearing last month about the blasting, they have received more phone calls from those living nearby and additional calls after CBS 42's Your Voice Your Station report.*[44]

Blast Vibration Damage 11

A group of more than 200 homeowners filed a multi-million-dollar class action lawsuit against Rinker Materials and six other companies over the effects of blasting limestone in Northwest Miami-Dade County.[45]

> *The group is seeking $22 million in damages, claiming the blasting has badly damaged houses, cracking walls, foundations and swimming pools.*
> *"We have a right to live in our homes and enjoy peace and quiet without having them violently shaken. We want this to stop and to also get some compensation for our damages," said Michael Pizzi, president of Citizens Against Blasting and a Miami Lakes community council member.*
> *David M. Wells, an attorney for Rinker Materials, said the Ocala-based company has been blasting in West Dade for 30 years and complies with Miami-Dade law. "We are completely confident that we have not caused any homeowners damages," he said. "We look forward to reading the lawsuit and hopefully sitting down with residents to do some talking."*
> *He said there has always been blasting in the area and the problem is that more homes are being built closer to the blasting site.*
> *The other companies named in the suit are Vecellio Realty Inc., WRQ Property Associates, Tarmac Florida Inc., Sunshine Rock Inc., Sawgrass Rock Quarry Inc. and Pelmad Corp. All are Florida-based and run operations in Northwest Dade.*
> *Although two of the firms are not blasting companies, Gonzalo Dorta, an attorney for Citizens Against Blasting, said they are also liable.*
> *"Those companies either subcontracted the blasting companies or own the land and pulled the permits to blast," said Dorta. He noted that under Florida case law the companies are responsible for any negligence resulting from ultra-hazardous activities, including explosions.*
> *Residents of the affected areas, which include Country Club of Miami, Palm Springs North, Miami Lakes and Hialeah Gardens, said blasting has continued unabated for the past two years. They said they have called county officials on numerous occasions to take action – all to no avail.*
> *"There was this one humongous blast recently, three to four times stronger than all the others. It felt like the earth moved," said Nanette Maccari, who lives in Country Club of Miami. "I could hear my house creaking. My bookshelves came crashing down and the chairs in my house were wobbling from side to side. I felt dizzy and I burst into tears."*
> *Maccari showed a notebook in which, she said, she has logged the time, day and damage of each blast for the past year.*
> *Some homeowners claim they've lost personal items as well.*
> *"See here, this is a picture of my daughter when she was 6 years old. It was shattered because of a blast," said Yolanda Arroyo, a resident of Palm Springs North.*
> *Pizzi said builders and real estate companies failed to notify some homeowners about the blasting. A Miami-Dade ordinance requires that prospective buyers be told if blasting is occurring within a two- mile radius of the home they contemplate buying.*

Note: Florida's blasting damage compensation statute was passed during the 2025 legislative session and took effect on July 1, 2025. It redirects all blast-related property damage claims to the Division of Administrative Hearings (DOAH), barring civil lawsuits. On June 17, 2025, Town of Miami Lakes Council voted unanimously to sue the state over the blasting law.[46]

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[44] Vincente, Chloe. "More neighbors report blasting damage following CBS 42 investigation," *CBS42*, May 7, 2021, https://www.cbs42.com/your-voice-your-station/more-neighbors-report-blasting-damage-following-cbs-42-investigation/.
[45] Yee, Ivette M., "200 Residents File Suit Over Blasting," *MiamiHerald.com*, 200 Residents File Suit Over Blasting. | Dorta Law.
[46] Herrera, A. (2025, July 2). *Council votes to sue state over blasting law*. The Miami Laker. https://miamilaker.com/News-Article/council-votes-to-sue-state-over-blasting-law

Blast Vibration Damage 12

On December 5, 2019, vibrations from a blast at a quarry in Raleigh County, West Virginia, shook homes and caused damage to property in nearby neighbourhoods.[47]

> *A series of explosions that have rocked Maxwell Hill residents for two years are the result of blasting at a rock quarry on Sand Branch Road, Raleigh County Emergency Operations Center officials said Thursday [December 5, 2019].*
> *Maxwell Hill resident Jim O'Dell, 79, said that he and his neighbor, Mary Peters, heard the blast at 4:07 p.m. on Thursday. He said that, for the past two years, he has heard loud blasts that tend to start at 4 p.m.*
> *The blast on Thursday was bigger and shook his house.*
> *"I always thought, 'That's manmade,' " he said. "But today, it almost shook the roof off of my house.*
> *"I've been living here for 47 years, and that's the heaviest blast I've ever felt."*
> *Several more residents called The Register-Herald to report the blasts. One caller was from the Bluefield area of Mercer County….*
> *Officials reported that the EOC does not receive prior notification from Appalachian Aggregates on days that the blasts are planned.*
> *They do receive calls from citizens, they reported….*
> *Another EOC official reported that several citizens had called EOC Thursday to report the blasts, which is not uncommon when the company is blasting.*
> *O'Dell said Thursday evening that the Thursday blast was not considerate of area residents or property owners.*
> *"Why are they shaking everybody's houses around here?" O'Dell asked. "That's too big of a blast. "It's bad enough to crack a concrete floor."*
> *O'Dell suggested that The Register-Herald call Del. Mick Bates (D-Raleigh). Bates owns Bodyworks, a health club in Maxwell Hill.*
> *"He doesn't want his chandeliers shook out of the ceiling," O'Dell added.*
> *Bates said he also heard the blast.*
> *"That was a pretty loud bang," Bates said. "I was doing other things.*
> *"I didn't feel anything here, but the percussion was pretty intense.*
> *"I didn't have any issues with power or equipment," he added.*
> *O'Dell's wife said the couple's ceiling was cracked after the explosion.*

Blast Vibration Damage 13

In November 2016, vibrations from a blast at the Sarawak quarry, Kemble, Ontario, then owned by Harold Sutherland, caused damage to the neighbouring Wilcox's home, for which they were inadequately compensated, and that terrified the family.[48]

> *We live at…Grey Road 1, Kemble…directly south of the proposed Sarawak Quarry Expansion. E lines of our property butt against this proposed expansion site.*
> *We built our home in 2006. The quarry we were told at the time was 'dead' by our real estate agent, and as such we purchased the land and built our dream home. Over the years we have built a couple of structures on our property…We recently completed renovations to the inside of our home, upgrading our kitchen…and created a walk-out basement only a few years ago…and spent several thousand dollars on concrete driveways and sidewalks….*
> *The expansion of this quarry means that trying to sell our property will become impossible because nobody will want to buy our house with quarry equipment stored in plain site [sic] of the house, as we currently have to view daily. Nobody will want to pay what our house is worth to look at this eyesore daily. Nobody will want to buy our house for fear the property (open field) to our north will become littered with more machinery, equipment, piles of things, trailers, rubble, rock, gravel, etc. And nobody will want to buy our house because of the constant noise experienced when these pieces of equipment and machinery come to and from this space.*

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47 Farrish, Jessica. "Quarry blasts cracks neighbors' ceilings," *The Register-Herald*, Dec 5, 2019, https://www.register-herald.com/news/quarry-blast-cracks-neighbors-ceilings/article_4eecbd93-1963-588e-a213-dfb7bf6c9a6b.html.

48 https://pub-georgianbluffs.escribemeetings.com/filestream.ashx?DocumentId=1422.

A blast occurred at the existing quarry in November 2016…That blast scared the living daylights out of my husband who was in the upstairs of our big garage when it went off, causing the drywall in the upstairs loft he was in to crack along most every seam. At the time this occurred, the Ministry, Township and County were all contacted by us, and we got the same story from everyone – that the blast was in acceptable limits.

We call bull on that – because acceptable limits do not cause my husband to flee from his place out of fear, and it certainly would NOT cause damage to our property Harold Sutherland sent an inspector to view the damage, and we were paid by them $500 to fix the damage. Our quote was more than twice this amount. So not only did this blast cause damage, it also caused us financial setback, distress, worry and fear it will keep happening, only for use to be told "it's all acceptable".

Blast Vibration Damage 14

In a 2003 lawsuit filed against Vulcan Materials, 57 residents sought to be compensated for damages to their homes from vibrations caused by blasting at the 137-acre Bellwood Quarry in northwest Atlanta, Georgia.[49]

Neighbors say blasting by quarry damages homes. Lawsuit by 57 residents calls for home repairs, end of detonations…

Mary Hollifield says she had to nail this painting to the wall to keep it from falling from the detonations at the nearby county-owned quarry. Officials of Vulcan Materials, which rents the quarry, deny their work causes damage.

Kitchen cabinets are coming loose from the walls, linoleum floors are sinking and ceilings are cracking. All this and more from dynamite blasts at the Bellwood Quarry in northwest Atlanta, say residents of the neighborhood next door. "I thought it was some kind of earthquake," said Anne Johnson, a 63-year-old part-time school crossing guard who lives in the adjacent Grove Park area. "I just want to be comfortable. That's all." Johnson and her husband, a retired cabdriver of 30 years, are still paying off their home on Francis Place that they bought for $8,500 in 1969….

The homeowners want Vulcan to stop blasting at Bellwood and to pay for damages to their homes….

The residents' lawsuit comes a month after state Insurance Commissioner John Oxendine said his office would examine the 1978 state code that governs commercial blasting to determine if it is too weak. The state decided to look into regulations after complaints from people who live near Hartsfield International Airport, where blasting has taken place to build a fifth runway. Residents there also want the blasting stopped….Residents are mostly low-income and predominantly black. Many residents are retired. "it's been traumatic," said Mary Hollifield, president of the Grove Park Neighborhood association and a retired teacher whose kitchen floor is sinking. "I like it here. I don't want to go anywhere else…"

The previous quarry renter, C.W. Matthews Contracting Co….sold that company's quarry rights to Vulcan in 1997. Before the sale, Matthews set aside $150,000 for a "residential neighborhood claim fund." The fund was "established for the payment of damages to any residence located adjacent" to the quarry. Residents found out about the money last year, when they sought help form Fulton County Commissioner Emma Darnell, who represents the area. The Grove Park Residents' lawyer, Cooper Knowles, said Darnell told the residents that a board would have to be appointed to decide if money was due….

Neighborhood residents say the blasts are occurring less frequently – weekly rather than daily as was the case when Matthews mined the quarry. Still, residents say in their lawsuit, the blasting violently shakes homes, causing structural damage including, but not limited to, cracks and holes in walls, ceilings, beams and foundations, broken water and sewage pipes, and broken windows….

Residents of Grove Park said they didn't begin to realize that the blasting was so destructive until many of them grew older and retired, meaning they were home more during the day when

[49] "Neighbors say blasting by Vulcan damages homes," *Aggregate Rsesearch.com*, May 9, 2003, https://www.aggregateresearch.com/news/neighbors-say-blasting-by-vulcan-damages-homes/.

> *blasting occurred. What they discovered are walls that rumble and pictures falling off the walls, they say. "I wish they'd stop," said Dorothy Mayes, 72. "I'm too old. I don't want to sell.*
>
> Note: On June 30 (2006), the city of Atlanta bought Vulcan's interest in its long-term lease for $25 million and Fulton County's underlying fee interest for $15.2 million. The quarry occupies 137 acres….and will be converted into a new 300-acre park and greenspace…[50]

Blast Vibration Damage 15

In 2003, Circuit Court Judge Markley Dennis of Moncks Corner ruled that the settlement of the class-action against Martin Marietta, operator of the Berkeley Quarry, was fair.[51]

> Attorney Dawes Cooke of Charleston, the 2003 court-approved settlement administrator, told The Times and Democrat Thursday that "any property owner (within a five-mile radius of Martin Marietta) was entitled to make a claim … "However, he said very little money has been awarded to landowners. He said he received a total of 675 "past claims," but some of the claims were rejected [emphasis added]. Cooke said the $1 million settlement fund was depleted last year (2008).
>
> …Carolyn Davis of 1467 County Line Rd. maintains that Martin Marietta has not kept its promise to the community.
>
> Davis said her roof leaks, her yard contains numerous sinkholes and she's been forced to purchase bottled water for 33 years because of the "rusty water" produced by her inadequate well. She said Martin Marietta previously dug a new well for her but "it didn't work."
>
> "When the people blast at the quarry, pictures fall off the wall" of her home, Davis said.
>
> "I haven't received any money from them. My septic tank has sinked in, and I don't have good water yet," she added.
>
> Davis noted that prior to the development of the rock quarry, she didn't have any problems with her well and she wasn't faced with constant home repairs.
>
> J.W. Garrett, who lives about a mile from the Martin Marietta site, said when the quarry began operating about 35 years ago, "it didn't take them long to do the damage." The blasts at the quarry "feel like earthquakes," he said, adding that "a lot of people's wells went dry" when the quarry work began….

Blast Vibration Damage 16

In According to a February 24, 2003, news release, residents of a Berkley County community rejected a settlement offer of $1 million from Martin Marietta's twin limestone Berkeley Quarry, on the Orangeville-Berkley county border of South Carolina, payable over four years to more than 700 residents to a 5-year-old lawsuit, with the potential to receive an additional $4 million over the next 40 years subject to several conditions. Any property owner within a five-mile (8.05-kilometre) radius was allowed to make a claim:[52]

> The company has offered $1 million to more than 700 Cross residents to settle the 5-year-old lawsuit.
>
> Residents say sinkholes, cracked brickwork and rusty water are the results of years of blasting at twin limestone quarries on the Orangeburg-Berkeley county border.
>
> They say the $1 million and a conditional promise of future reparations for damages is not enough.
>
> Carrie Spann and other members of the Concerned Citizens of Cross Committee plan to help neighbors fill out as many opt-out forms as possible before a March 15 deadline.
>
> "The best way to send a message that we are unhappy with the proposed settlement is to opt out," Spann said. "The quarry wants us to accept this settlement. Not only will they be rid of us, but also future generations -forever."
>
> The proposal states those who accept the settlement and their heirs lose the right to sue Martin Marietta. [underscoring added]

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[50] https://www.atlantaga.gov/home/showpublisheddocument?id=1677.

[51] Maratha Rose Brown, "'We need our money,' say picketing residents near MMM quarry," September 14, 2009, https://thetandd.com/news/we-need-our-money-say-picketing-residents-near-mmm-quarry/article_1075045c-1b39-54a2-9f0e-ac9b6c44c93f.html

[52] "Many Cross residents reject Martin Marietta settlement," *Associated Press*, Feb. 24, 2003. https://www.goupstate.com/story/news/2003/02/25/many-cross-residents-reject-martin-marietta-settlement/29661709007/

> "If too many people opt out, they have the right to withdraw the agreement," Spann said.
> Cross residents want to send a message to Circuit Judge Markley Dennis to reject the proposed settlement as unfair. Dennis is expected to rule April 1.
> Thirty-four people had opted out before the original Jan. 20 deadline.
> If Martin Marietta withdraws the settlement offer, the two sides could try to reach another settlement, or the case could go to trial.
> "If a large number opts out and Martin Marietta pulls the settlement off the table, then you go back into a trial mode," said Chris Holmes, a residents' attorney.
> If the suit is settled under the current proposal, Cross residents' lawyers will get $1 million. If Martin Marietta withdraws the offer, the attorneys won't get paid until a new offer is negotiated.
> Residents would get $1 million over four years, the life of Martin Marietta's mining permit, if they proved their damages were caused by quarry blasting. They potentially could get another $4 million over the next 40 years.
> The 40-year offer has a loophole, Spann says.
> It requires Martin Marietta to pay $100,000 a year for future damages, but it's based on the company's annual sales of quarry material, with 5 cents per ton going toward the future claims pot. If the company didn't meet its tonnage, it wouldn't have to pay, Spann said.
> About 60 percent of 100 or so residents at a community gathering last week indicated they would opt out….

In 2003, Circuit Court Judge Markley Dennis of Moncks Corner ruled that the settlement of the class-action against Martin Marietta, operator of the Berkeley Quarry, was fair.[53]

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> "When the people blast at the quarry, pictures fall off the wall" of her home, Davis said.
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> J.W. Garrett, who lives about a mile from the Martin Marietta site, said when the quarry began operating about 35 years ago, "it didn't take them long to do the damage." The blasts at the quarry "feel like earthquakes," he said, adding that "a lot of people's wells went dry" when the quarry work began….

Blast Vibration Damage 18

The Coalition for Responsible Environmental Aggregate Mining (CREAM) (2024) conducted a survey in Williamson County, Texas, from March to June 2024.[54,55] The results indicate that 97% of respondents reported adverse impacts on their property, air quality, and overall quality of life, and reside within a radius of approximately 0.5 to 2 miles (805 to 3,219 metres) of quarry boundaries.

- 97% of respondents had personally experienced negative impacts that damaged their property or degraded their quality of life.

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[53] Rangle, Lauren. WilCo survey highlights concerns regarding rock quarries, push for new regulations," *Fox7*, June 13, 2024

[54] Coalition for Responsible Environmental Aggregate Mining (CREAM). (2024, May 17). *Better neighbors: Aggregate production operations in Williamson County*. Greater Edwards Aquifer Alliance. Retrieved from https://aquiferalliance.org/wp-content/uploads/2025/08/Better-Neighbors-APOs-in-Williamson-County_final.pdf

[55] Rangle, Lauren. WilCo survey highlights concerns regarding rock quarries, push for new regulations," *Fox7*, June 13, 2024. https://www.fox7austin.com/news/williamson-county-rock-quarries-survey-regulations

- 90% experienced vibrations from quarry blasts.
- 44% had property damage from quarry blasts.
- 60% observed excessive dust accumulating on their properties, raising concerns about air quality.
- 89% expressed concerned about decreases in their property value.
- Many residents were "unaware of the proximity and intensity of aggregate production operations (APOs) until after moving in." Several individuals explicitly stated they were not told about nearby quarry activity or blast-related impacts when purchasing their homes.
- Narrative responses indicated that real estate disclosures were lacking, and that blast vibration, dust and truck traffic were unexpected post-purchase discoveries.

The survey collected responses from 177 individuals, with only one response which was pro-quarry, over a three-month period. Based on these findings, CREAM continues to advocate for stricter regulations aimed at mitigating quarry-related disturbances and fostering a more sustainable relationship between aggregate operations and local communities.

AUTHOR'S DECLARATIONS AND ESSENTIAL ETHICAL COMPLIANCES

Author's Contributions (in accordance with ICMJE criteria for authorship)
This article is 100% contributed by the sole author. He conceived and designed the research or analysis, collected the data, contributed to data analysis & interpretation, wrote the article, performed critical revision of the article/paper, edited the article, and supervised and administered the field work.

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The author(s) solemnly declare(s) that this research has not involved any human subject (body or organs) for experimentation. It was not a clinical research. The contexts of human population/participation were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of Helsinki Declaration does not apply in cases of this study or written work.

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(Optional) PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)
The author(s) has/have NOT complied with PRISMA standards. It is not relevant in case of this study or written work.

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